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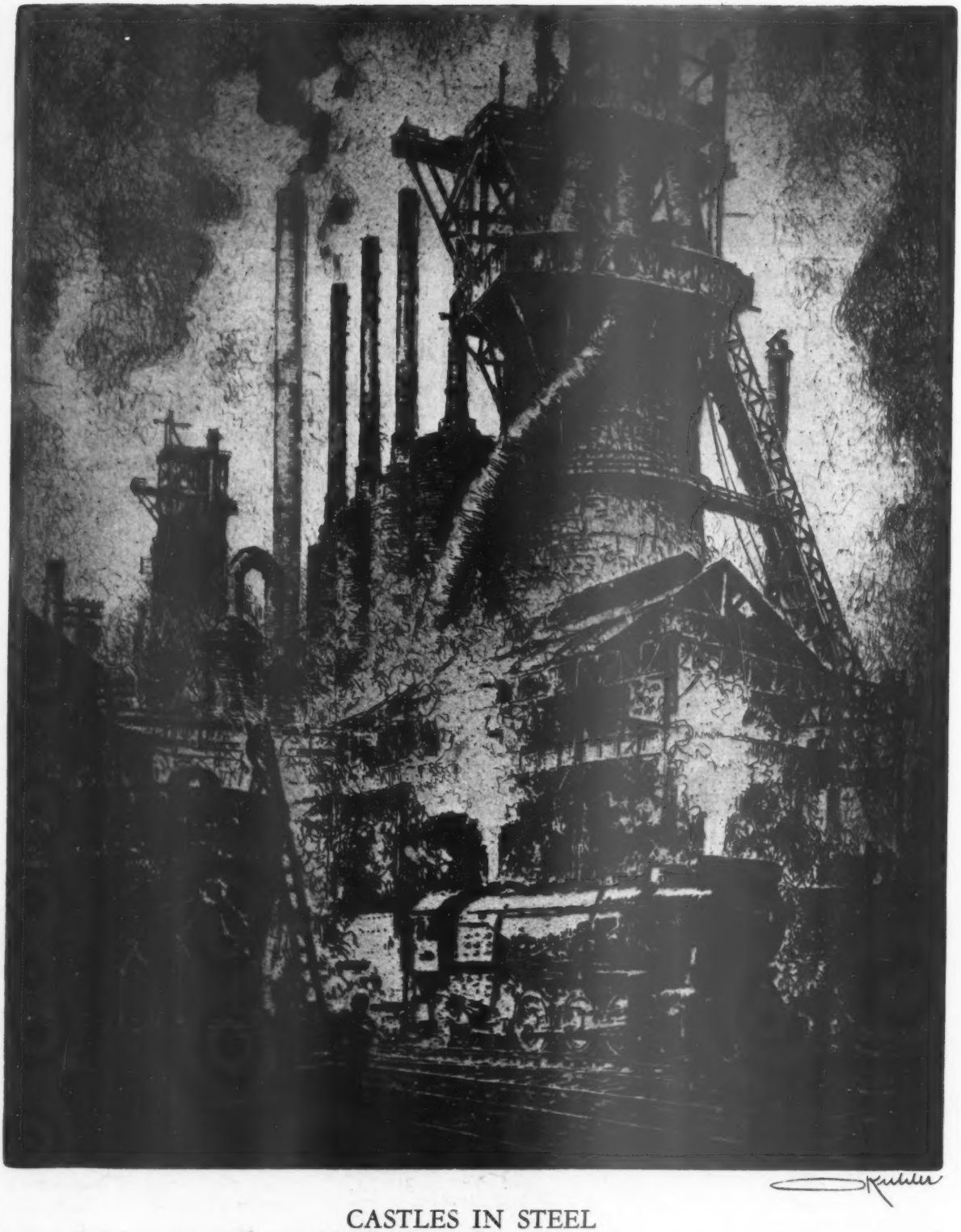


CASTLES IN STEEL

FROM AN ETCHING BY OTTO KUHLER

Courtesy Goodspeed's Book Shop

THE TECHNOLOGY
REVIEW

VOLUME 33 DECEMBER, 1930 NUMBER 3

RADIO'S GROWING PAINS

Retarded by Patent Snarls and Legal Difficulties, It Nevertheless Approaches Technical Adulthood—Its Oligarchical Tendencies

BY HAROLD B. RICHMOND

ALTHOUGH radio telephony has been in use for well over 20 years, the last decade has witnessed the development of broadcasting, and with it the growth of radio from an insignificant unit in our economic system to a billion dollar industry. Including the amplifier field, represented by the reproducer equipment used in the talkie theatres and group-address systems, the annual output at consumer prices of the radio and vacuum-tube industry is $1,200,000,000. This is approximately the same as the output of the rubber goods and tobacco industries, or the amount expended by the combined railroads of the country in their repair shops. Such a prodigious expansion must of necessity have been attended by many acute economic, engineering, and legal problems, and even today as radio settles down to a reliable unit in our country many of these problems still exist.

In surveying the present state of the industry, three groups present themselves for investigation. First, there is the broadcaster who places the programs on the air; then there are the manufacturers, including the distributors of receiving sets; and finally, the consumers, or, in radio terms, the listeners. These three interdependent groups are comparable to those involved in the distribution of news by the newspapers. The broadcaster is analogous to the advertiser, the manufacturer to the newspaper organization, and the listener to the reader. Just as the reader pays only a small fraction of the publication cost, so does the listener pay but a minute portion of the cost of radio broadcasts.

M. I. T. Photo

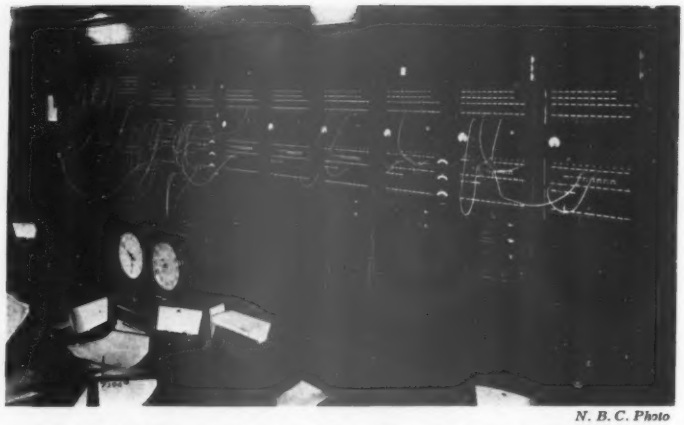
AN ANTENNA TOWER OF THE INSTITUTE'S SHORT WAVE STATIONS AT ROUND HILL, MASS.

The listeners may be dismissed by the statement that they desire free programs pleasing to their taste, with a quality of reproduction equal to the original and free from offense. Most listeners are generously tolerant of the ratio of direct advertising to entertainment. Here again the listener is in much the same position as a reader of a newspaper. About one-half of the newspaper is devoted to paid material, and it is this fact that makes it possible for the reader to purchase his paper for only a small fraction of the total cost. But, always, the publisher holds reader interest to be of prime importance. It is the analogous listener interest which is the goal of successful broadcasting.

It will not be until the actual commercial establishment of wired radio, that is, programs sent into the home over electric service or telephone wires, that we shall have a true measure of the listeners' viewpoint on advertising. The wired radio plans call for a monthly rental charge to defray both the operating and program expenses, keeping these programs free from all advertising matter. In view of high program costs, it is doubtful if the large mass of listeners would actually pay this program charge in preference to tolerating a reasonable amount of advertising in order to obtain their programs free.

The radio manufacturer who supplies the raw material and machinery for radio broadcasting is always dependent upon the broadcaster and the listener. Not only does he owe his existence to good broadcasting, a situation over which he has but little control, but also to our new

economic status brought about through machine production. It is by producing more through machine production that the worker is able to have more, which lifts him from the condition of bare existence to one in which he is able to buy items of the luxury class, such as radio receivers. His purchases, therefore, give employment in new fields to those made idle in older fields through the efficiency of machine production. In this manner radio gives equivalent, annual full-time employment to about 130,000 persons. Since there is much part-time and seasonal work, the actual number associated with radio work is much higher than the figure given. Chain broadcasting by making necessary an extension of telephone toll circuits has also helped the employment situation. At the inauguration of President Hoover over 30,000 miles of telephone toll circuits were utilized in the radio broadcast. These circuits are of a much higher quality than the usual telephone toll circuits, because the transmission of music requires a frequency band nearly three times as wide as that necessary for satisfactory telephone conversation. The construction and maintenance of these circuits provides employment for many persons and is a true by-product of the radio industry.

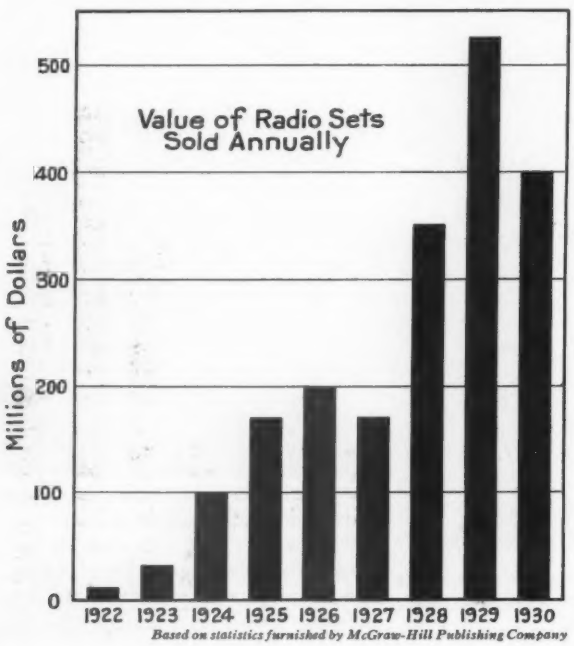


N. B. C. Photo

SPEECH INPUT CONTROL PANELS IN THE CONTROL ROOM OF THE NATIONAL BROADCASTING COMPANY

IS THE growth in radio manufacturing being made at the expense of some other industry? Is the use of a radio receiver in the home eliminating that of musical instruments? Or is the dissemination of news by radio supplanting the newspaper? At first there was a real reason for raising such questions; but is there any today?

There can be no question that the novelty of music by radio at first had its harmful effects on the sale of phonographs. But phonographs are like radio; they are not primary instruments, since they only reproduce. Today we find the radio and the phonograph combined, the one assisting and supplementing the other. My question, however, deals with primary musical instruments. Following the war, there became apparent a serious indifference toward music, both on the part of the public and on the part of musicians as well. There is today a renaissance, both in taste and interest; people who once thought Bach the proprietor of a delicatessen shop and who never heard of Brahms are beginning to know and love music. Classical themes are being hummed by day laborers, and even college students know that Palestrina was not a dancer of questionable reputation. Can there be any question as to the important part the national distribution by radio of the concerts of our greatest orchestras or the songs by great artists has had in this growing consciousness of the importance of music in America?



Based on statistics furnished by McGraw-Hill Publishing Company

There can be no question but that the radio has replaced the special editions of newspapers as the quickest medium of broadcasting the results of special events. It is equally certain that radio broadcasting is a most important factor in making us news-conscious, and thereby exciting a desire to read the full story in the press.

A ten-minute news summary by radio seldom covers over 1,000 words. On this basis, and with most liberal allowances for headings, it would take at least an hour to present the material of a single solid page of a metropolitan daily. No, the radio is a salesman for the newspaper, rather than its competitor.

What is obsolescence in a radio receiver? In the early days of broadcasting, advances were made so rapidly in receiver design that sets became quite useless in one or two years. Does this situation still exist? No.

What makes a set obsolete? Perhaps this could be answered by asking another question: what makes an automobile obsolete? Certainly the addition of more cylinders, spark plugs, chromium plating, or other similar embellishments to this year's car does not make last year's car ride any the less comfortably, or render it less serviceable. The new model simply represents an improvement in the art.

In a radio receiver, the operation has been reduced to single dial control for several years. From an operating point, little improvement is required. What then are the

N. B. C. Photo

THE MODERNISTIC INTERIOR OF THE NATIONAL BROADCASTING COMPANY'S LARGEST STUDIO

three points in which we should look for improvement? They are: selectivity, sensitivity, and fidelity. A radio receiver must be sufficiently selective to enable it to separate the different broadcast stations so that the programs will not be mixed within the receiver. All modern receivers have a high degree of selectivity and no radical improvement is necessary. Improvements in methods to accomplish this result are possible, but as they are only accomplishing the same result, they will not render sets obsolete. Such concatenations as Rudy Vallee crooning a love ballad along with an Amos-'n'-Andy obbligato are a thing of the past.

Sensitivities are now obtainable that were of remote speculation a few years ago. Every station that is received comes in with sufficient volume to operate the loud speaker. The sensitivity of receivers is so great that selection may be made from a wide variety of stations. With the continuous extension of excellent chain broadcasting, little is to be gained in extreme sensitivity; therefore, there is available in the present set all that is required from a sensitivity viewpoint.

Wonderful improvements have been made in the fidelity of reproduction in radio receivers. A thoroughly modern receiver handles a range of frequencies sufficient to give the equivalent of original tone quality. Only minor improvements are necessary in this direction.

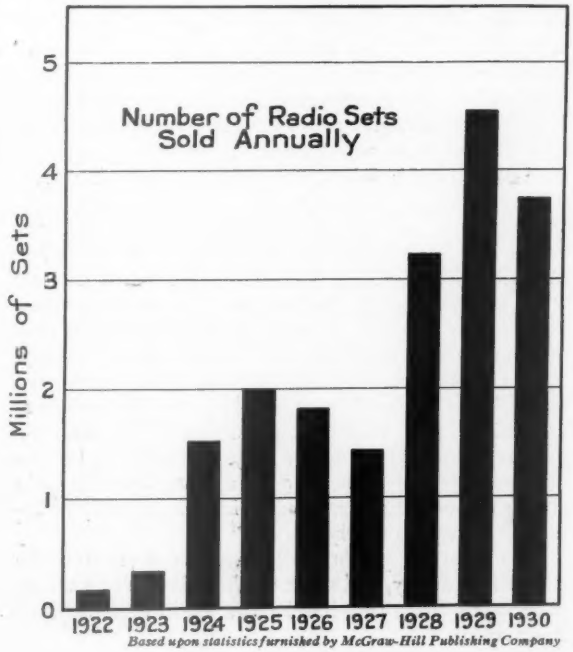
With a receiver now available which, through its all-electric operation requires no attention to batteries, through its single dial or even automatic tuning requires no special skill on the part of the user, and with superb quality of reproduction, is it not foolish to believe that existing sets will become obsolete with great rapidity?

This whole problem of stability has brought a new problem to the radio manufacturer. His greatest sales in the last three years came from the replacement of obsolete sets. This market will soon be nearly closed to him, since obsolescence will become but a very small factor. He must look to the extension of the use of radio, or, as has been the case with the automobile, to the use of more than one radio in a home. This latter situation is developing with great rapidity. No longer is a single radio set sufficient for many people, but radio service is desired in various parts of the home. The simplest way to obtain such service, particularly when a variety of programs is desired, is through the use of more than one radio set. That this field is a most promising one is evidenced by the fact that during the current radio season fully one million of the midget or mantel-piece radio sets will be sold. A great many of these sets will be sold in homes where there is another radio receiver.

What about television? It is still quite in the experimental stage, but making excellent progress. It should, however, be remembered that this is an entirely additional feature. It is something to be added and not part of an existing receiver. It is much the same as adding talkies to the ordinary movies. It represents additional equipment, and is not merely an improvement in existing radio sets. Because of expense its use in the average home is relatively remote.

THE radio manufacturer is confronted by a patent situation without parallel in any other highly competitive industry. There are about 8,000 radio patents, the control of about half of which are in the Radio Corporation of America group. A vast number of these patents are the result of developments in the telephone field, which have now become of great importance in the radio and allied entertainment fields. Much of the radio patent litigation has been to determine whether patents issued in other fields such as that of the telephone have broad enough coverage to include radio. The bulk of the decisions have been in favor of the validity of the patents as extending to radio.

Radio is today the most litigated patent group. It has even become the subject of Congressional action. The regenerative circuit patent contested as to ownership between the American Telephone and Telegraph Company



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International

GERMANY'S NEW RADIO CENTER, DEDICATED DECEMBER 1. BROADCASTING STUDIOS, A MUSEUM, LABORATORIES, AND GENERAL OFFICES OF THE COMMISSION ARE COMBINED IN THE CENTER

and the Westinghouse Electric and Manufacturing Company is probably the most expensive piece of litigation in patent history, exceeding the Selden patent of automobile fame. Both contestant companies are parties to the Radio Corporation agreement.

The superheterodyne patent held by the Westinghouse Company has been hotly contested as to ownership, and stands today a key patent in the radio licensing situation. The entire electrification of a radio set is dependent on another patent, the validity and ownership of which have been in contest for about two years and which appears to be far from settled. Any patent group issuing licenses may suddenly find themselves the subject of federal investigation, and every attempt at an equitable solution has so far failed; there still remains the Damoclean threat of litigation. The independent manufacturer finds himself loaded with royalties and with daily demands that he take licenses from new groups. Radio started out as a most democratic industry. The patent situation is rapidly forcing it into an oligarchy.

Unfortunate as such a situation may become, our patent law in its protection to the inventor makes just such situations possible. The owner of a patent may use it for his own benefit. He need not license others unless he so desires. A group of patent holders may license each other under favorable terms and license outsiders, namely, their competitors under entirely different terms. The real point of contest is whether the patents so combined are valid — have they been adjudicated? Any one company is seldom able to fight a large combination, because not only are the financial odds against them, but the chance of upsetting every patent in a large group of important patents is nearly nil.

As a solution, patent pooling has been proposed for the radio industry, and much constructive work has been undertaken along this line by the Radio Manufacturers Association.

STANDING as it does as the guardian of the public interest in radio matters, the Federal Radio Commission has had a most difficult position. The administration of its affairs in the public interest should be based on engineering and legal considerations, modified as is necessary by the economic aspects. It, however, has been forced to take a stand in many matters as a direct result of politics, rather than as the result of engineering or legal data. This has been brought about quite largely through the expected lack of understanding of radio engineering principles on the part of the members of Congress.

General Saltzman, the Chairman of the Federal Radio Commission, recently stated: "Of all the utilities used by the people on this earth, radio is probably the one most difficult to regulate. Owing to the fact that these radio waves travel in every direction, if you are to regard state limits, it makes more than national regulation necessary. A fifteen-year old boy, fooling with an amateur short wave on his father's farm in Iowa may interfere with a land station in South Africa. German ships, coming over to our shores, with wave lengths assigned by the German government, must not interfere with our land stations. Cuban stations must not interfere with Mexican land stations. American airplanes, flying over the border into Canada and Mexico, must be able with the frequency assigned by our government to communicate with stations in those countries."

The Federal Radio Commission was set up and its duties prescribed by an Act of Congress, approved February 23, 1927, There have been some amendments pertaining to the set-up of the Commission itself, but only one important amendment pertaining to the administration of radio facilities. This is the Davis Amendment, which has been such a problem to the Commission.

It was the intent of Congress to provide equal radio facilities throughout the country. To assist in carrying out their desires and the administration of radio matters, the country was divided into five zones. These were zones used in another grouping quite remote from radio. They are wholly unadapted to radio services. In its provision that each zone should have equal transmission facilities, it utterly failed to take into consideration that the fifth zone is eight times as large as the first zone. These zones are somewhat based on population, but unfortunately, radio waves do not radiate in proportion to the population. Distance and topography are the important factors.

Congress felt that the Radio Commission did not carry out its desire for equal radio facilities as expeditiously as should have been done. To force them to take action, Congress passed in 1928 an amendment to the Radio Act, known as the Davis Amendment. This amendment prescribes that radio facilities shall be divided among the states of each zone on a general basis of population. Again this Act of (*Continued on page 152*)

MAKING MAPS FROM THE AIR

By Crockett A. Harrison

Illustrations by Courtesy Fairchild Aerial Camera Corporation

PICTURE SECURED AT EACH EXPOSURE OF THE FOUR-LENS BAGLEY TYPE FAIRCHILD CAMERA. EACH COMPOSITE VIEW COVERS A GROUND AREA OF 15.3 SQUARE MILES IF TAKEN AT AN ELEVATION OF 10,000 FEET, AND 43 SQUARE MILES FROM 15,000 FEET

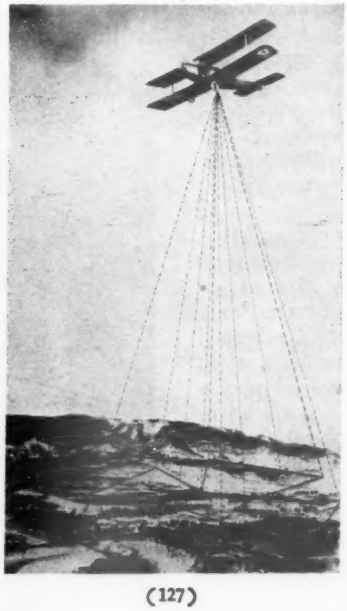
IF TAKEN FROM AN ALTITUDE OF 20,000 FEET, 74 SQUARE MILES WOULD BE COVERED. THE CAPACITY OF THIS CAMERA WHEN LOADED WITH FILM IS SUFFICIENT TO PHOTOGRAPH THOROUGHLY A GROSS STRIP AREA OF 800 SQUARE MILES FROM AN ELEVATION OF 10,000 FEET

CARTOGRAPHERS have become photographers and surveyors have taken to the air. Yet the ordinary citizen (and many who are technically trained as well), while nodding hearty approval to aerial surveying and mapping as an abstract idea with great possibilities, knows but little of the technique of the art. He possesses no real conception of the extensiveness of its use today, nor is he aware of its growing value for the prosecution of manifold human enterprises.

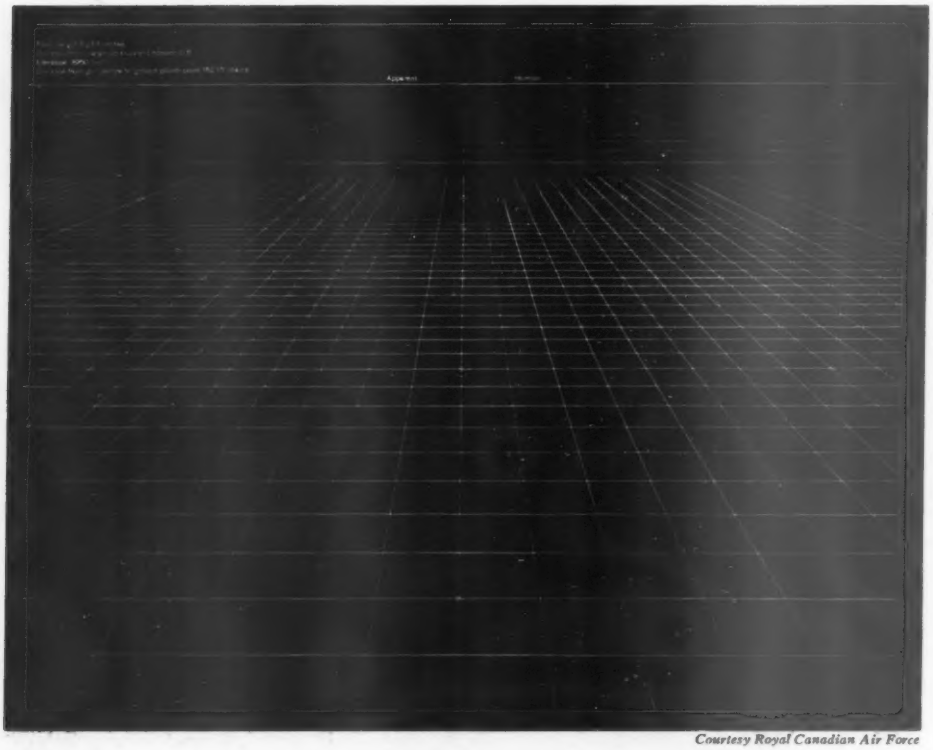
One may confine a discussion of the progress in photographic surveying from airplanes to the decade of 1920–1930 and still include most of the significant steps by which this exceedingly useful art has emerged from the chaos of its initial stages, although this decade does not include certain pioneer feats such as the air survey of Flanders and Picardy by the British in 1916–1917.

As a method of making maps to plan high tension power and transmission lines without arousing the suspicion of landowners that a right-of-way was being contemplated, the air survey method made its earliest appeal and, up to 1924, about 25 corporations had availed themselves of it for such a purpose. Meanwhile it was being tried successfully for reservoir surveys, early examples being the mapping of 500 square miles of the Tallapoosa River Valley in 1923 for the Alabama Power Company under the direction of its chief engineer, Oscar G. Thurlow, '04; a 2,000 square-mile survey of the Tennessee River Valley by the War Department at about the same time; for harbor mapping at Mobile, New Orleans, and Boston; for city maps to aid in traffic studies, for taxation purposes, for landscaping of parks and parkways, and in formulating zoning determinations.

BELOW: SHOWING HOW THE DIFFERENT CHAMBERS OF THE T-2 AERIAL CAMERA COVER THE AREA BEING PHOTOGRAPHED



Kansas City, Newark, and New York were among the first municipalities to use it. Two air maps of New York (400 square miles on a 600-foot scale and a "Regional" one covering 625 square miles on a 2,000-foot scale) were ordered July 10, 1923, and delivered by April 15, 1924. The year 1924 also saw the demonstration of a camera by which, on May 2, Lieutenants Macready and Stevens of the Army Air Corps were enabled to make a photograph of Dayton, Ohio, from an altitude of 32,220 feet. This single photographic print showed an area of 19 square miles! A few years later Stevens flying with the stunting ace of



Courtesy Royal Canadian Air Force

GRID USED IN MAPPING OBLIQUE PHOTOGRAPHS. THIS SYSTEM HAS BEEN PROVED HIGHLY SUCCESSFUL BY THE TOPOGRAPHICAL SURVEY OF CANADA

the Army Air Corps, Capt. James H. Doolittle, S.M. '24, reached an altitude in excess of 37,000 feet. A series of perfect photographs were made in spite of an approximate temperature of −70° F. and the seven odd miles of intervening atmosphere.

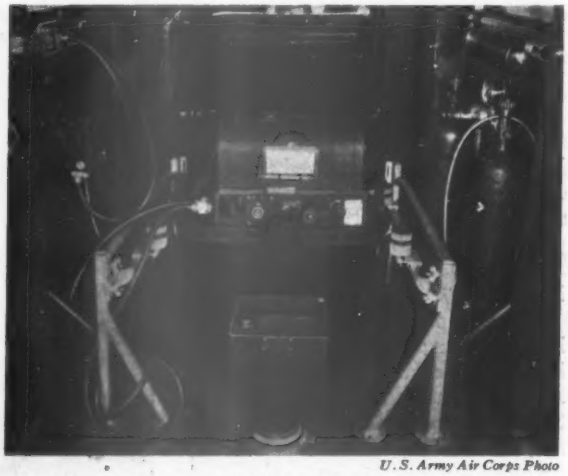
In sparsely settled areas as well as congested centers it was readily apparent that mapping could be expedited by aerial photography, especially in regions where difficulties of the terrain, climate, absence of water, and transport impeded the progress of land parties. The aerial method in such regions literally surmounted the hitherto arduous task of getting over the ground imposed by the presence of high mountain ranges, deep canyons and desert wastelands encountered in the Southwestern United States, and by the countless lakes and practically impenetrable muskeg swamps of Canada. In Canada, air maps as a means of estimating stumpage, quickly pointed the way to the supersession of the old-time timber cruiser.

Governmental agencies concerned with completing geological and topographical surveys of vast areas were quite receptive to the new method. During 1924, 11,500 square miles in Texas alone were covered by the Army Air Corps coöperating with the United States Geological Survey, and the outgrowth of early experimental work in Canada has resulted, up to the end of 1929, in photographing 339,075 square miles by the Royal Canadian Air Force for the use of the Topographical Surveys Branch and other governmental departments of the Dominion.

An early example of its use for flood control studies is found in the airmap of 325 square miles of the Colorado River Delta. There, in a territory subject to shifting channel conditions and flooding from the river's overflow, the planning of levees to protect the adjacent and very fertile Imperial Valley was made possible without the hardships, enormous expense, and delay incident to the use of ground surveying methods. Similarly, aerial photography was invoked by the Survey of India to map the swamps and forests of the Irriwaddy Delta.

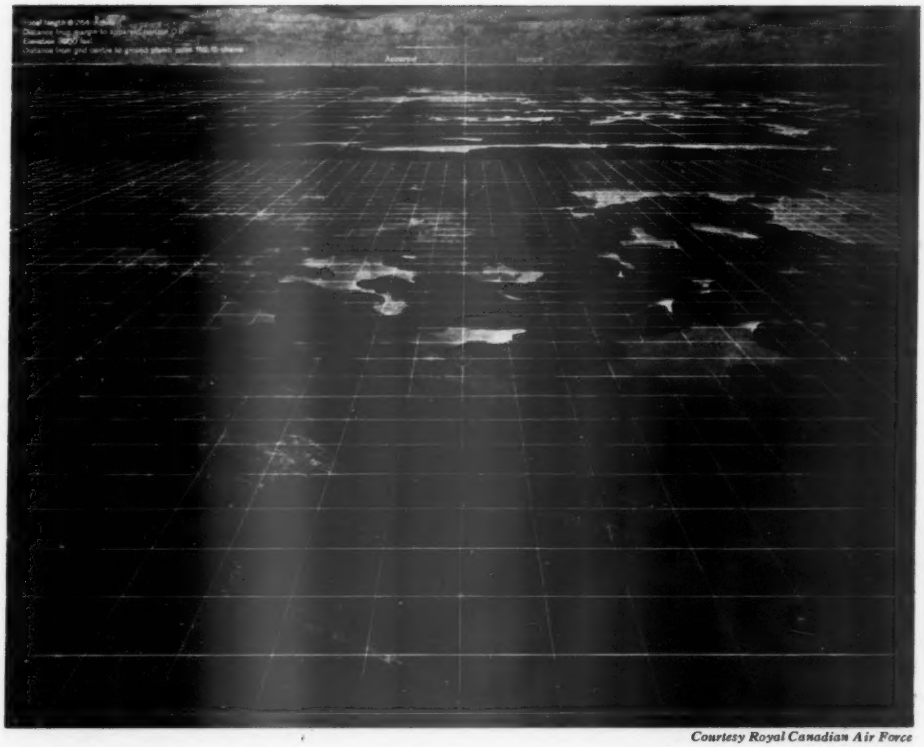
It is a far cry from these not-so-old but nevertheless pioneer accomplishments to the present-day possibilities. Now, for practical purposes, we stand at the close of the first ten years of the history of aerial photography in surveying and find under way stupendous air-mapping programs which less than five years ago would have seemed fantastic.

Begun a year ago, as recorded in The Review for December, 1929, this winter's five-month schedule calls for the photographing of an additional 9,000 square miles of the lower Mississippi Basin for flood control studies. Contracts for this were let by the War Department last October to the Curtiss-Wright Flying Service which will use



U. S. Army Air Corps Photo

FAIRCHILD AUTOMATIC MAPPING CAMERA MOUNTED IN FAIRCHILD CABIN MONOPLANE



Courtesy Royal Canadian Air Force

OBLIQUE AERIAL PHOTOGRAPH WITH THE GRID SHOWN ON OPPOSITE PAGE IN POSITION—A METHOD DEVELOPED IN CANADA

five planes to make the 14,000 exposures necessary. To keep under the allowable one per cent error limit, these planes must fly constantly within a ten-foot range of a 12,400-foot altitude. But, as this cannot always be accomplished, even with the finest piloting aided by the sensitive new-type Paulin altimeters, it will probably be necessary to enlarge or reduce most of the 56,000 photographs to scale, thus illustrating one of the factors which still make for high production costs in aerial surveying. Besides the work in the lower-Mississippi Basin, Fairchild Aerial Surveys are at present engaged in mapping the Missouri Basin from the mouth of the river to Yankton, South Dakota, and another organization is mapping extensive areas in the Ohio Valley. The Missouri River project includes approximately 2,500 square miles and the Ohio River project approximately 1,000 square miles. Probably the largest strictly commercial undertaking of the past season was a continuous strip map two miles wide extending from the Texas Panhandle to Chicago, a distance of approximately 1,000 miles. The survey was made for the construction of a natural gas pipe line and the entire field work was completed in less than 60 days. Lloyd M. Long, '23, of the Dallas office of Fairchild Aerial Surveys directed operations.

U. S. Navy Photo

PERSONNEL AND EQUIPMENT OF THE U. S. NAVY ALASKAN SURVEY EXPEDITION IN 1929

An African citation is afforded by the Aircraft Operating Company, Ltd., a British concern, which last month announced the completion of the photographic work on an air survey of Northern Rhodesia. Flying at elevations of about 21,000 feet, a total of 15,000 photographs were taken of open country in addition to 700 of several townships. In four months data was obtained which, with ordinary ground survey methods, would have required eight years. Parenthetically, this company during last year completed, or had under contract and incompleted at the end of 1929, 88,000 square miles of surveying.

Progress such as indicated above has come about not alone because the idea of aerial surveying made an early appeal and proved itself practical in trials on a small scale, but because of the marked improvement in cameras, photographic airplanes and other equipment, and because, from the accumulated experience of map-makers, there have been evolved recognized standards of practice.

IN ITS simplest form in the United States, making a map by means of aerial photographs is accomplished by assembling them into a mosaic. A camera is installed in a plane with the lens pointing downward through a hole in the bottom of the plane. Upon an available quadrangle map of the U. S. Geological Survey, or other suitable existing map, the area to be covered is noted and "guide of flight" lines determined. The altitude at which the plane should fly is obtained as follows: If the area in question is to be mapped at a scale of 1 inch equals 800 feet

Courtesy Royal Canadian Air Force

SHOWING RELATIVE AREAS MAPPED BY OBLIQUE AND VERTICAL METHODS. THE OBLIQUE METHOD IS MOST PRACTICAL WHERE THERE ARE LARGE AREAS OF FLAT COUNTRY

and a 12-inch lens is to be used, multiplication of the two factors (800×12 equals 9,600) gives the altitude in feet which the plane must maintain.

In making an actual survey, the pilot flies along the "guide of flight" lines, back and forth, forming "strips" until the entire area has been photographically covered. The consecutive exposures are timed so that they overlap each other like shingles by about 60% and the "guide of flight" lines are spaced so that the strips overlap each other by about 50%. This overlap makes it possible to use only the central portion of each photograph which alone is in true vertical projection; the overlap moreover, allows stereoscopic study of the terrain, which adds the third dimension, or perspective, to any portion of the ground covered.

After the photographs are developed the scale ratio of each print is carefully figured, checking to known distances on the equivalent terrain. Any inaccuracies of scale are corrected by this ratio figuring and then each print is rephotographed to a common accurate scale. The central portions of these corrected photographs are assembled into a "mosaic" of the terrain covered, triangulation points, highway and railway maps, and data from field notes being used as "controls." A negative of the "mosaic" itself is then made and from prints of this negative are produced copies of the finished air map.

Cameras are now available which register automatically the year, month, day, hour, minute, and second a photograph is taken; the level condition of the camera; the altitude; number of the exposure and the focal length of the lens on each photographic negative. An intervalometer provides for automatically tripping the camera shutter at a predetermined interval which is exactly right to secure the necessary overlap of a photograph on the one preceding. The recording feature is seldom incorporated on aerial cameras for commercial use, but the automatic operation feature is extensively used. It is in military operation that the recording camera is valuable. A pilot with such an instrument installed in a fast pursuit airplane can fly at extremely high altitudes and a great speed to map an extensive area without the help of a camera operator. Every photograph will contain a record of the data previously mentioned.

But the field of view of each picture made by the usual single lens mapping camera covers only a restricted area. For instance, a single lens camera (*Continued on page 149*)

THE ANATOMY OF X-RAYS

New Uses for the Rays, the Wave-Length of Which Approximates the Diameter of an Atom

By Karl T. Compton

ONE of the latest of the long succession of modern miracles of science is the discovery that x-rays can be used to hasten the process of evolution — that process regarding which scientific evidence has for so long been in conflict with superstitions and prejudices. The new discovery is this: if a germinating seedling be exposed to strong x-rays, there is a considerable chance that it may develop into a new species, bearing perhaps little resemblance to its parent stock and capable of reproduction and self-perpetuation. For example, ordinary tobacco plants thus treated by x-rays gave rise to species of dwarf and to giant plants, twelve feet tall. Similarly flies, so exposed to x-rays, occasionally have offspring with strange characteristics. Similar, though less frequent, results can be produced with gamma rays of radium, which are rather similar to x-rays.

Here then is a modern miracle: by means of x-rays it appears possible to a certain extent to produce in the laboratory some of those changes which have been assumed in the theory of evolution, and there is, indeed, reason for suspecting that many of the new species which geology records in past ages, arose in this way as the result of the x-ray-like gamma rays from the radium which is always present in a slight amount in the earth. It appears quite possible, for example, that by this means new types of plants may be produced which will be of great value in agriculture.

But this is only one example of what x-rays can do. It is well known how they can pass through the body, or other objects which are opaque to ordinary light, and produce on a photographic plate or on a fluorescent screen a picture of the hidden insides of the body through which they have passed. This use of x-rays has entirely revolutionized diagnostic medicine, and is of industrial importance in detecting flaws in welded metal joints, castings, armor plate, and so forth. It is also well known that x-rays are valuable therapeutic agents in the treatment of certain diseases such as cancer.

To the chemist and physicist, x-rays have been a wonderful servant, for they have enabled him to count the electrons in an atom and to study the ways in which atoms are arranged in molecules or in crystals. In fact it is almost true that all we know about the insides of atoms has been learned by the aid of x-rays.

HAVING been told of these things which have been accomplished by use of x-rays, I can imagine the layman asking, "Just what are x-rays, anyway?" In fact, that was the very first question which was asked about them when they were discovered in 1898, and for more than a dozen years no one could give a definite answer. For that very reason they were called *x*-rays, the x being the symbol of an "unknown quantity." About all that was known about them was that they traveled in straight lines, that they had great penetrating power, that they could affect a photographic or fluorescent plate, and that they were able to destroy the electrical insulating property of air or other gases.

Now it is known that x-rays are really like radio waves or light waves. Whereas a radio wave has a wave length of several hundred feet, and a light wave has a wave length of about ten-thousandth of an inch, x-rays have wave lengths of about a hundred millionth of an inch. In fact the wave length of an x-ray is about as long as the diameter of an atom, and to this fact it owes its peculiar properties.

The discovery of x-rays is one of the most interesting stories in modern physics. Back in the 1890's, physicists were much excited in investigating those peculiar and striking phenomena which occur when electricity at a fairly high voltage is impressed on the ends of a glass tube containing rarefied gas. Imagine a long glass tube, with a metal wire inserted into each end, and containing gas which may be pumped out by some kind of vacuum pump. If the gas pressure is varied while the voltage is maintained impressed upon the wire electrodes at the ends of the tube, a whole succession of surprising and spectacular occurrences are observable. If we start with a tube full of gas at atmospheric pressure and slowly pump out the gas, there is at first nothing observed, since the gas is a good insulator and the voltage is insufficient to break down this insulation and force an electric current through the gas. If the gas is gradually pumped out of the tube, however, a certain degree of rarefaction will be reached at which a spark passes the length of the tube, and with slightly increased rarefaction the tube is filled with a long, thin, wavy, luminous streamer marking the region in the gas through which the electric current is passing. As the vacuum becomes still better with further pumping, the current through the gas increases rapidly and this streamer expands until the whole tube is filled with a brilliant glow.

At this stage the tube is nothing more nor less than an example of those street sign lighting tubes of neon, mercury vapor, or other gas which now adorn our city streets at night. As still more gas is pumped out, this luminous glow breaks up into well defined regions separated by dark spaces, — some of these regions occurring with a surprising regularity along the tube as alternate light and dark striations. These various luminous regions may be of different colors, and they behave quite differently as still more gas is pumped out of the tube, since the luminous striations move toward the electrically positive end of the tube and there disappear, while a fainter glow from the negative end of the tube gradually expands until it alone fills the entire tube.

From this stage on it becomes more and more difficult to force the electricity through the tube, since the currents become smaller and the requisite voltage becomes higher, — and at the same time the glass walls, particularly near the negative end, begin to glow with a greenish fluorescence. With modern vacuum pumps the air can be pumped out of these tubes until the luminosity of the gas has become too faint to be detected by the eye, whereas the glass walls of the tube now glow brilliantly with the green fluorescent light. Finally, at really high vacuum, the whole process ceases, since a perfect vacuum is, of course, a perfect insulator. Is it any wonder that scientists 40 years ago were fascinated by these phenomena and, failing to explain them spoke of the existence of a "fourth state of matter" in these evacuated discharge tubes?

AT THIS point I will relate the course of two experiments, both performed a little over 30 years ago by scientists of high ability, both starting out with the same objective, the one leading to no great result, the other leading to an epoch-making discovery — the difference between them being due to the difference in attitude of the two men toward an unexpected complication.

Sir William Crookes having at his disposal an improved vacuum pump was investigating the phenomena described above in the stage of high exhaustion when the glass walls of the tube glowed with green fluorescence, and for the purposes of record he attempted to obtain photographs of the tube under its various conditions of operation. He was greatly annoyed to find that his entire batch of photographic plates had become light-struck and were worthless. He secured a new batch of photographic plates and made another attempt, and these plates also quickly became light-struck. He finally, however, solved the difficulty successfully by moving his supply of photographic plates into a neighboring room, after which he had no further trouble and proceeded successfully with the experiment which he had set out to perform.

During the same year the German scientist, Wilhelm Konrad Röntgen, was also undertaking the same study and attempting to photograph the glowing tube under various conditions of operation. He also found that his photographic plates became light-struck, but, instead of avoiding this by moving his plates into another room, he set about to investigate the reason for this fogging of his plates, and traced it to the existence of very penetrating invisible radiations emanating from the discharge tube when under the condition of greenish fluorescence existing when the tube was in a very high state of exhaustion. Thus, by accident, were discovered the Röntgen rays, more commonly nowadays called x-rays. This was just a couple of years prior to the discovery of electrons, which also followed from the attempts of Sir J. J. Thomson and others to explain the phenomena in these electric discharge tubes containing rarefied gases which I have described above. Then it was immediately suggested that the x-rays were, in fact, radiations produced by the bombardment of the glass walls or of any solid target by high speed electrons, much as sound radiation is produced when a bullet strikes a target. This suggestion has since been abundantly verified.

I suppose there have never been any two discoveries in science which were so quickly seized upon all over the world and which so quickly revolutionized man's ideas regarding the structure of matter as these two, the discovery of electrons and the discovery of x-rays. If one looks over the bibliographies of that period one may be puzzled to note that even in the United States there were published x-ray photographs through various parts of the human body and there were inventions of improved forms of x-ray tubes appearing even before the publication of Röntgen's great article describing his own discovery. This is due to the fact that Röntgen first announced his discovery to a small medical society, and the news of that announcement quickly spread through the scientific world, but his publication in a leading scientific journal was delayed for more than a year. At any rate within two or three years, around 1900, the x-ray tube had been developed to a passably satisfactory state as a practical device for medical and scientific work. These early x-ray tubes were simply geometrical modifications of the early gas discharge tubes in which the x-rays had been discovered. They produced good x-rays but were erratic in their behavior, owing principally to the fact that the amount of gas in the tube changed during and between operations.

THE next stage of development which brings the x-ray tube essentially to its present highly efficient state, is very closely bound up with a simultaneous and similar development of the radio tube, both being applications of the phenomenon of evaporation of negative electricity, in the form of electrons, out of hot metals, a phenomenon which had been first clearly understood and investigated by Richardson in about 1904, and which has even up to the present time been one of the most active fields of scientific and industrial research. The particular development of the x-ray tube came from a realization by William D. Coolidge, '96, of the General Electric Company, that with the aid of a hot filament to supply a current of electrons, and with the aid of improved methods of securing high vacua which he and his colleagues had developed, there arose the possibility of doing away entirely with the gas in an x-ray tube as an agent to convey the electricity through it, and of producing x-rays directly by simply bombarding a metal target with electrons which had been evaporated out of a neighboring hot filament and then directed swiftly toward the target by the high voltage applied to the x-ray tube. Thus was designed the modern Coolidge x-ray tube which is in practically universal use.

While I was a research student in Princeton in 1911 Professor Richardson, who was in charge of my work, came very near to making the discovery that x-rays are wave radiations similar to light but of much shorter wave length, and had he done so he would have antedated the first proof of the wave nature of x-rays by von Laue, Friedrich and Knipping about a year later. Richardson knew that if x-rays were like light waves it should be possible to refract them with the aid of a prism. Certain reasons led him to the idea that a prism of iron might be particularly suitable, and so he carried out extensive experiments in an attempt to refract a beam of x-rays by passing it through the edge of a (*Concluded on page 158*)

AMERIKANISMUS

In Germany an Engineer Learns the Truth about Americans

By Hunter Rouse

LIESL, the German *Zimmermädchen* who cares for my room, just came in to turn down the bed-covers, lay out my pajamas, and wish me a good night's rest. The sudden question, "Liesl, what do you think of America?" rather took her unawares, accustomed as she is to my ungrammatical inquiry as to the next day's weather, but she must have caught my meaning, for her reply was exactly what I sought. "America is a land of money and money-chasing people; I'd like to work there — but live in Germany." That is the *Amerikanismus* concept in its simplest, commonest form.

We "money-chasers" are surely the most highly blessed race of all the world insofar as gratis criticism is concerned. From the native magazine writer, to the self-exiled American in permanent residence on the continent who sends his opinions home for publication — not to mention the European who is prolific in his statements after a four-day tour of the States — everyone who has a single thought on the matter gives it freely, till the burden of analyzed error would seem almost more than any shoulder could bear. But we are either inherently thick-skinned or so toughened by experience that we seldom bother even to smile tolerantly. To be sure, we have solved very easily and typically this problem of unending censure, but with it we have lost in large measure the ability to listen when some view of actual worth is presented — to distinguish valuable comment from sheer headline flourish.

A foreign country offers the most promising field for search; but just as one must go alone and live the life of the country to learn that country's life, so must one do to learn that country's genuine thoughts about our land of wealth and promise across the seas. A year of study as a hydraulic engineer in a different world has surely given me a new outlook upon American civilization — that is inevitable and entirely a self-contained process — but through the eyes of the German people has come a keener comprehension of the life we are wont to live.

To understand the German outlook, one must consider for a moment or so under just what conditions the German mind has to function. Twenty years ago the empire had reached almost the pinnacle of world prestige — *Kultur*, colonies, manufacture, education, science, engineering, the arts — in all these Germany held avowed leadership, with only one or two other powers who were her equal. She developed a national pride which became a byword to her people, literally a propaganda. Then came the Great War; who was to blame is quite beside the point; surely not the *Volk*, for when one listens to the serious comment of those who lived through the crisis, one even begins to question the Allied doctrines the slightest trifle!

Through Versailles, political revolution, inflation of currency, a decade and more of reparations payment with tremendous taxation and millions of inhabitants without employment, the country has been reduced to almost a

Galloway

GERMAN STEEL WORKS AT MULHEIM, RUHR VALLEY

Galloway

GERMAN HYDRO-ELECTRIC PLANT ON SALACH RIVER IN BAVARIA, SOUTH OF REICHENHALL. GERMANY IS WORKING HARD TO DEVELOP HER VAST WATER RESOURCES. LONG THE CENTER OF HYDRAULIC RESEARCH, SHE IS ESPECIALLY APT IN THIS FIELD. IT WAS THIS FACT WHICH TOOK THE AUTHOR OF THE ACCOMPANYING ARTICLE OVER THERE TO WORK AND STUDY IN THE GREAT HYDRAULIC LABORATORIES. AMERICA IS FAST REALIZING THE VALUE OF THIS WORK

shadow of the old empire. True, the people are the same, and their pride can never be conquered, be it the result of habit or genuine belief. But with empty purses, compulsory taxes that make accumulation utterly impossible, is it little wonder that the *Volk*, whether of Liesl's class or the comparatively well-to-do, look upon the neighbor across the ocean with a feeling ranging between envy and bitterness?

Simultaneous with this purely financial change came further alterations, each with its own peculiar influence upon the German mind and vision. The "Made in Germany" regime is at such a stand that American products are now widely used in Germany, and American enterprises are controlling many a German firm. Previous military stiffness is being rapidly superseded by a prevalent turn to gymnastic and competitive sport. The morals of the post-war generation have made an almost radical departure from the old-age decorum, with an accompanying freedom and naturalness that would abash even an American. And the experiment with smoothness and efficiency in republican rule has made a heated politician out of the most taciturn citizen of former years. All these points must one bear in mind if one will weight the German views to their true intrinsic worth.

Liesl gave us the *Amerikanismus* concept in its basic state. Let us advance a step to the group gathered perforce for the evening meal in a Münchener Pension, the most assorted collection of average human beings one could wish. The elderly *Pensionsmutter*, a hearty Royalist with a portrait of the ex-Kaiser above her bed, is a fair specimen of her order. She likes Americans on the whole, in spite of a resigned tolerance for their obvious poor breeding, for they pay well and are not so class-conscious as others, and she has fallen in love with each male guest in turn for countless years. Next in importance comes the equally elderly *Northgerman* spinster, who has spent a good two decades teaching languages in England, and returned to Germany with the typical English aloofness toward all things savoring of the American. (This, it must be noted, seems to be passed on to every student of the "real" English language on the continent.) But she is surprisingly well informed on all that exists on the other side — so well that she was once bluntly enlightened upon the sundry points in which an American considered her the most in error, and behold, in this former proudest of the proud of the old continental *Kultur* we now have a staunch supporter of the tremendous vitality and youth that exists in the new world.

From there we may pass on to the four or five young girl students, for the most part excellent sketches of the new generation (to our Lindsey is attributed this metamorphosis), with a lone example of the inexperienced pre-war type. The others are of every sort: an army officer or so at times, artists and students of several nationalities, and the general flow of two-day guests. Dinner-table conversation is generally lively enough with the *Northgerman* spinster at the helm and a Norwegian pessimist to spur her on; after an amused allusion to this and that American weakness, it takes a fairly international turn, especially when the unlikely happens and the Americans present can speak the language. But once let the room be free of all visitors from the land of wealth and promise, and not a fault of ours but what is brought to light, beaten, pummeled, stripped naked of excuses before the grim multitude — and then filed carefully away in memories, to be reviewed at the next round-table.

RECENTLY I attended a travel lecture by a professor who has world-wide repute in his field, after one of his trips through the States. He is a member of several American professional societies, follower of the best American engineering journals, and never hesitates to make friends with Americans who chance his way. However, this lecture was for the Germans, and consisted principally of pointed jokes at the expense of American fallacies and the proof that without German brains, American wealth would be useless. It is what the *Volk* seem to want, and it is only natural that he, as a popular figure, would give it to them.

Newspapers and magazines follow much the same trend: cartoons of the brain-pocketbook alliance, and ever-recurring citation of the case of this and that German scientist or engineer who designed (*Continued on page 160*)

THE TREND OF AFFAIRS

A Sermon on Glass

ALTHOUGH the glass industry probably dates back to the fifth or sixth millennium B.C., it has been one of the last of man's great industries to adopt scientific methods. Only within the present century have the weapons of modern science been employed to discover the actual nature of glass, and only now are the glass manufacturers realizing that they have been too secretive and too exclusive in jealously guarding their pet processes, that they must more and more rely upon scientific research. They have developed a remarkable *art*, handing down their formulae from generation to generation, but it now behooves them to make a *science* of their art.

This is particularly true now that great opportunities present themselves for using glass more extensively. For instance, if the glass manufacturers can reduce very slightly their costs of making glass containers, they can probably substitute glass for tin as the most important material for containers. Already glass has nearly displaced stoneware, and the industry is making serious inroads into the whiteware field, as colored glass is becoming popular for the table.

The fact that glass is a liquid has been fairly well established for many years (new research just announced may indicate a crystalline structure), but it was not until recently that the exact conditions of glass phase were determined. The Geophysical Laboratory of the Carnegie Institution of Washington, realizing the necessity of more scientific knowledge, has been conducting a fine program of research and has added much to our knowledge of the physico-chemical relationships in glass. Knowledge of these relationships should add greatly to an understanding of such properties as thermal expansion, heat conductivity, the refractive index, and of the variation of these with varying compositions. At the present time such knowledge is fragmentary and incomplete.

In England the Society of Glass Technology is sponsoring research, and likewise the Department of Glass Technology at the University of Sheffield. At the latter place has been written one of the two or three comprehensive textbooks extant upon glass technology. The Bureau of Standards in Washington has done notable work, particularly in optical glass, but very little work has been done in the universities. There is no body in the United States comparable to the English Society of Glass Technology, but there is a division of the American Ceramic Society devoted to glass technology. Under the direction of Professor Frederick H. Norton, '18, extensive work is being carried on in the Institute's Ceramic Laboratory on the manufacture of colored glasses and glazes. Another problem studied by Professor Norton is the development of a refractory for glass melting tanks. One of the most serious problems in the glass industry is to find a refractory which will resist the molten glass and not throw off seeds or strings. A refractory block of pure kaolin has been designed, and it is giving excellent service in comparison with the usual fireclay blocks.

Obviously glass making holds great possibilities for the application of scientific methods, and undoubtedly great progress will be made in the immediate future. Science developed pyrex glass, and showed how it could be combined with other glasses (Dr. Frederick Keyes, Head of the Institute's Department of Chemistry, contributed to this solution). Science can do even more useful and spectacular things for the glass manufacturers, if they will only realize that their private trade secrets may not be the last word in glass making.

Opportunities for glass in the container field mentioned above will only be good if the glass technologist can prove himself as active and as good a scientist as the metallurgist. The latter is making available new metals for canning (stainless steel, alloys) and he is showing how certain old ones may supplement tin (aluminum).

Harold Willoughby

THE FOOD CHEMIST: DR. HENRY BORG IN THE LABORATORIES OF WALTER BAKER & COMPANY, INC.

Galloway

LOADED AND AIMED: KLEMM AEROMARINE LOW-WINGED MONOPLANE

A Discourse upon Anæsthesia, or Queen Victoria's Chloroform Child

CHLOROFORM and other anæsthetics employed to alleviate the pain of surgical operations and parturition are among the greatest boons that science has conferred upon mankind. It is fitting, therefore, that next year the one hundredth anniversary of the discovery of chloroform should be marked as a notable milestone in human progress.

Its discovery was made almost simultaneously by three men in three countries: Leibig in Germany, Soubieran in France, and Samuel Guthrie, Jr., in the United States. Leibig and Soubieran made almost simultaneous publications of their discoveries, but Guthrie several months earlier had stumbled onto chloroform while trying to make ethylene chloride in his backwoods laboratory in New York State. Not until 1847 was its use brought forcefully to the attention of the medical profession. In that year, Dr. James Y. Simpson, professor of obstetrics at the University of Glasglow, employed it to relieve the suffering of a woman giving birth to a child. Its use for this purpose met with great public disapprobation and a controversy ensued over the propriety of abolishing the pains of parturition. It was not until 1853 when Queen Victoria accepted it for the delivery of her seventh child, Prince Leopold, that chloroform and other anæsthetics were popularly accepted.

Ether is much older than chloroform although a convincing and influential demonstration of its value as an anæsthetic by Dr. Morton at the Massachusetts General Hospital came only a year earlier than Simpson's use of chloroform. The first to describe the preparation of ether by action of oil of vitriol on alcohol was Valerius Cordus (1515–1544).

Paracelsus, whose real name was Philippus Aureolus Theophrastus Paracelsus Bombast ab Hohenheim (1490–1541), described an "extract of vitriol" which possessed "an agreeable taste." "Even chickens will eat it whereupon they sleep for a moderately long time, and reawake without having been injured."

Sir Humphrey Davy, Bart. (1778–1829) discovered in 1799 that pure nitrous oxide is perfectly respirable and he recorded how he became "absolutely intoxicated" through breathing 16 quarts of it for "near seven minutes."

Another pharmacological anniversary falls this year—the tercentenary of quinine. One of the most effective weapons for fighting malaria, its discovery in Peru was the entering wedge that brought about the end of Galenism and the beginning of modern medicine. The year 1931 also is the fiftieth anniversary of the discovery by Alphonse Laveran of the parasites causing malaria.

Vanishing Timber Supply?

NO thinking person who has even the slightest interest in posterity can remain indifferent to the suggestion that our timber supply is rapidly being

depleted to make paper, and it is true that 85% of our annual $900,000,000 consumption of paper has its origin in the forests while in 1870 the entire production in the United States from woodpulp was valued at only $172,350. But it is equally true that only 4% of the drain on this country's forests is used today for pulp and wood chemical purposes, which proportion is but a tenth of the amount used for fuel, an eighth that used for lumber, and less than half the loss due to fires, tree diseases, and insects. Yet this 4% cares for nearly half our total yearly pulpwood, pulp, and paper requirement, the chief item of which is 4,000,000 tons of newsprint.

Obviously, however, the demands of wood for pulp as well as for other purposes may be expected to increase and, though much of the amount imported is produced by American capital, both the problem of an adequate foreign supply and the wisdom of continuing to import over half our total needs give cause for concern. That this matter of a foreign supply is one of moment was shown by the furor due to the temporary embargo in New York harbor last August of the *Christian Bors* and *Groslile*, the first of several shiploads of Soviet pulpwood from the Archangel district, being delivered in fulfillment of a contract between the International Paper Company and Amtorg.

Some of our imports come from Newfoundland and Scandinavia but Canada is our chief source today. Her exports of newsprint alone are second only to her exports of wheat and are greater than the newsprint exports of the rest of the world. In 1929, according to preliminary figures from the Dominion Bureau of Statistics, her newsprint production (85.2% of the manufactured products of her pulp and paper industry) was 95% greater than that of the United States.

Recognizing that our domestic source of wood for pulping and other purposes is a reproducible natural resource, professional forestry has made headway during the past 30 years. It is now conservatively estimated that the amount of new growth can probably be extended to exceed more than our present timber demands. Reforestation and intensive cultivation are, however, but part of the program.

Europe has found means of coping with the forest fire menace and in Scandinavia the annual loss has been curbed to 500 acres. Last year in the United States 200,000 fires burned an area twice that logged. Nearly a third of these fires were due to carelessness, more than a third to incendiaries, only 6% to natural causes. Our annual growth approximates six billion cubic feet and the losses in standing timber due to fire, diseases, decay, and insects is placed at 2.4 billion cubic feet, while the loss due to decay of wood in service and storage accounts for 4.0 billion cubic feet. Forest pathology is now getting acquainted with causal fungi to prevent epidemics such as chestnut blight, white pine blister rust, and European larch canker. It is estimated that if approved practices at present known were generally applied, the drain on our forest material would be lessened to the tune of $195,000,000.

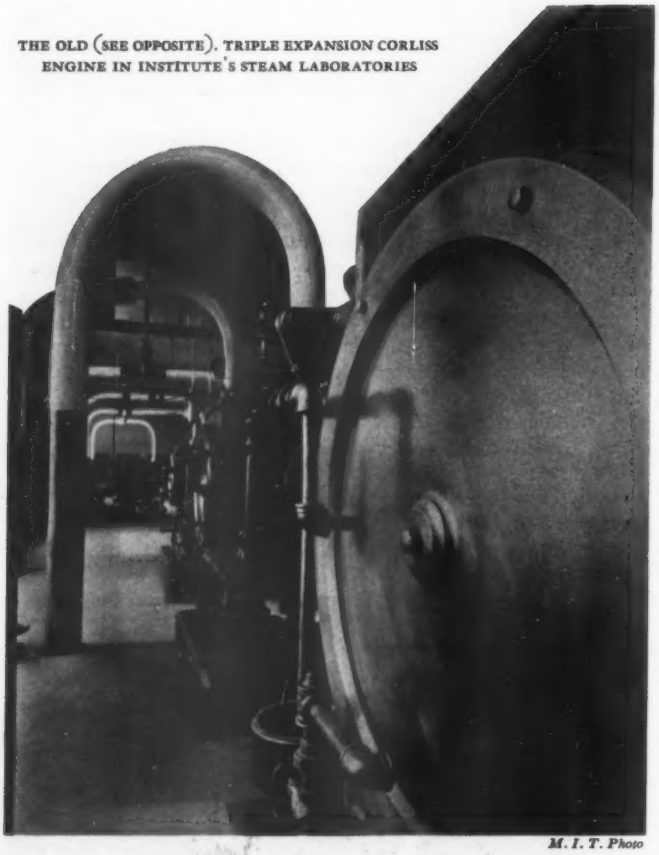
Many European countries afford in their tax systems examples of forest conservation by taxing timber not while it stands but when it is cut. In the United States annual taxes on timber holdings often force them into premature liquidation although a few states have recently voted to defer taxes on *growing* timber. Only one, however, extends the "sound tax yield principle" to mature timber.

Hitherto the pulp and paper industry in the United States has been centered chiefly in the northeastern section, east of the Mississippi and north of the Mason and Dixon Line. There are found the important stands of spruce, fir, and hemlock east of the Rockies area and from these three species has come 76% of the pulpwood used. Now attention is turning to the West, South, and Alaska.

In the South are little spruce, fir, or hemlock of importance to the papermaker, but there is yellow pine and 20 years is sufficient to produce trees of this type in pulpwood size. Full-grown shortleaf pine on fully stocked land after 20 years will yield about 38½ cords per acre or nearly 2 cords per year; northern spruce requires 40 to 80 years to reproduce itself and yields only about ½ cord per acre per year. Thus four times the area is required, on a sustained yield basis, to supply a mill using spruce as compared with a mill using a like quantity of southern

Galloway

COUNTER-WEIGHT CHAIN USED TO HOIST THE LIFT SPAN OF HACKENSACK RIVER BRIDGE



THE OLD (SEE OPPOSITE). TRIPLE EXPANSION CORLISS ENGINE IN INSTITUTE'S STEAM LABORATORIES

M. I. T. Photo

pine. Moreover in the north, climatic conditions are not conducive to continuous harvesting of wood and the decay losses in storage piles of 50,000 to 100,000 cords are a factor. Gumwood is also available in the South.

Alaska offers enormous possibilities and, as pointed out in The Review last February, the U. S. Forest Service estimates that the total volume of timber in the panhandle is sufficient for producing 1,000,000 tons of newsprint a year without depleting the supply. Besides excellent water-power resources, tidewater transportation from forests to mills and from mills to markets, there is, paradoxically, an equable climate to permit plant operation and unhindered shipping throughout the year and a plentiful rainfall to minimize fire losses.

In the development of new sources of supply as well as forest conservation, the U. S. Forest Service has played a major part. Of the annual expenditures in forest research in the United States (about $3,000,000) half is by the Federal Government, and about 8% by states, $100,000 by endowed institutions and $1,000,000 by the wood-using industries.

Industrial research into the treatment and uses of wood products is obviously the duty of the wood-using industries and in this the pulp people have made by far the most progress. Pulp products are now in extensive competition with sawn lumber and wood products in their natural form, wood fiber board boxes and insulating board are manufactured wholly or in large part of wood fiber.

Significant, therefore, is the new coöperative lumber industry-owned research laboratory in Washington established by the National Lumber Manufacturers Association of which Dr. Wilson Compton is Secretary. It indicates that the example of other American industries which spend over $100,000,000 a year for industrial research with gains running into the billions, is now to be applied to the "vanishing timber supply."

Sunburn on Cloudy Days

WHY does it frequently happen that a worse sunburn is obtained on a cloudy day than on a clear day? Why is the burning effect of the sun greater at the seashore than in the mountains?

Work in the Departments of Physics and Biology at the Institute has suggested tentative answers. The infrared rays in sunlight tend to neutralize or inhibit the action upon the human body of their brother ultraviolet rays. Diffuse infrared rays seem to have difficulty passing through clouds or mist. Therefore, on days when the infrared is decoyed by clouds, the ultraviolet (which is likewise lessened by clouds), works its physiological changes without so much neutralization, and its effects are greater. Since there is less moisture in the mountains than at the seashore, there is more inhibition of the ultraviolet by the infrared and consequently the ultraviolet effect is abated in its severity.

This inhibiting effect of infrared rays was suggested in a report on the prevention of rickets by ultraviolet presented before the fall meeting of the American Public Health Association at Fort Worth, Texas, by Professor John W. M. Bunker and Robert S. Harris of the Institute's Department of Biology and Public Health.

Their report, based upon a two-year study of 800 rats, revealed that a much wider range of ultraviolet rays than hitherto thought acts in the prevention or treatment of rickets. The wave length range generally thought effective is between 3,022 and 3,026 Angstrom units, such a unit being about one two hundred and fifty millionth of an inch (.000,000,001 meter). When this range is extended to include ultraviolet rays of shorter wave lengths, greater ricket protection is obtained.

Frozen Foods

THE food technologist and the cryogenic engineer, joined in scientific marriage, are proving themselves strikingly fecund. The best known and most promising of their progeny is the process of quick freezing of foods at extremely low temperatures. By this method many perishable comestibles, the gastronomic delights of which have hitherto been confined to a season, can now be preserved in their natural state indefinitely. The coming commercial application of quick freezing, now in the pioneer stage, will be another triumph in man's conquest over time and deterioration.

Not since the discovery of means for making artificial ice, and the development of refrigeration, has any advance in food technology held such interesting possibili-

ties for economic and sociological change. Just as the application of refrigeration in transportation obliterated seasonal limits on a few foods, so quick freezing seems likely to bring further readjustments in human food habits, and perchance, actual physiological changes in the course of time.

Preservation of food by existing cold storage methods has certain limitations of time, and cannot be successfully applied to all foods. The slow freezing method in general use is likely to cause marked changes in texture in the products treated. In fruits, for instance, separation of water in the form of ice occurring in and between the cells, which is not absorbed during thawing, breaks down the structure and leaves the fruit soft and unpalatable, according to studies carried on by M. A. Joslyn of the University of California. He explains that during slow freezing, water is withdrawn from the cells to the intercellular spaces where the ice first forms. As freezing proceeds, the crystals grow and the spaces become filled with ice and the cells may be forced apart by ice pressure.

But in the new methods of quick freezing no such breaking down occurs, for at low temperatures the entire tissue freezes rapidly, the ice crystals forming within as well as between the cells. W. H. Chandler of Missouri Agricultural Experimental Station has studied injury to texture by slow freezing and has come to the conclusion that this effect is more than a merely mechanical disrupture of tissues by ice crystals. There are indications, he finds, that the effects may be due to changes in the colloidal condition of the cells. These changes apparently do not occur in quick freezing.

Quick freezing extends the economic horizon of food preservation and conservation to limits undreamed of a few years ago. It holds meats, sea foods, fruits, and vegetables in a state of original color and flavor indefinitely, and in its economic aspects the process injects a new factor of balance in the problem of supply and demand. Its benefits will accrue to the producer and the consumer in a year-round market unaffected by seasonal crops.

The field of development in quick freezing includes all kinds of meats, popular cuts of which already are being sold in attractive packages. Fruits that hitherto have been picked before they were ripe and marketed under seasonal disadvantages may now be allowed to reach full maturity in color and flavor and then be preserved for year-round enjoyment. Expressed fruit juices are also being preserved with slight loss in natural flavor. Quick freezing has already been applied to apples, strawberries, peaches, plums, cherries, and even ripe figs and raspberries, both of which are extremely perishable at ordinary temperatures. Sea foods are particularly adaptable for long term preservation at low temperature, and the United States Bureau of Fisheries sees high promise for the quick freezing of oysters, which research has shown can now be held in an edible state for at least 27 months. It also seems likely that quick freezing will be employed in the preservation of dairy products, and many other foods.

Now that quick freezing has been developed to a commercial stage, there remains the major problem of distribution. Public opinion, once suspicious of frozen foods, is turning in favor of quick frozen products. The success of this new food industry depends to a great extent upon a dis-

Galloway

THE NEW. OVERHAULING THE ROTOR OF A TURBINE IN THE HELL GATE PLANT OF THE UNITED ELECTRIC AND POWER COMPANY

M. I. T. Photo

TORCH-CUTTING

tributing system that will bring foods to the consumer in the original frozen state. This means new methods of refrigeration in transportation, and proper means for maintaining low temperatures in the retail establishment.

Refrigerant Therapy

AESCULAPIUS, the legendary physician and God of Medicine in Greek mythology, was slain by Zeus because Pluto complained that the prolongation of life on earth due to the administrations of Aesculapius was decreasing the population of Hades. This is probably the only instance in which a doctor has been punished for being too successful. Modern doctors, fortunately, are not faced with so discouraging a fate, a situation which the facetious may attribute to an overpopulation of Hades.

Aesculapius might have been slain much earlier had he the aids of present-day science at his disposal. Since the Renaissance the medical profession, wearing the seven-league boots of scientific method, has made enormous strides. Not the least interesting aspect of this progress is the quickness with which the doctors find uses in their own science for the discoveries made in the non-medical sciences.

Instances leap to the mind — x-rays, radium, ether. A recent one, the use of refrigerants for the treatment of skin diseases, is at hand. Both liquid air and carbon dioxide snow have been appropriated by dermatologists for the treatment of skin lesions.

The principle underlying the use of refrigerants is that of the production of an inflammatory reaction in the living tissues by sudden freezing. A wide range of reactions is possible, from a superficial dermatitis to the complete destruction of the frozen area. The advantage of this method lies in the fact that a relatively deep inflammatory process can be produced without necrosis, the freezing causing an interstitial sclerosis.

It should be carefully pointed out, however, that the only dermatologic lesions that are treated by carbon dioxide snow or liquid air are small growths and deposits of pigments. The claim has been made that eczema and psoriasis yield to this treatment, but The Review is informed by the Bureau of Investigation of the American Medical Association that leading dermatologists hold an unfavorable opinion of this form of treatment. They admit, however, that the refrigerant treatment might conceivably have some value in cases where the diseases are limited in area and are of an extremely chronic form.

Rather than allow this item to create false hopes, we hasten to add that corns and bunions do not respond favorably to this treatment.

Harden the Surface and You Save All

SUCCESS in producing a steel of unusual core toughness, surface hardness, and great resistance to wear by the new process of nitriding, is the realization of a dream that has long been an inspiration in metallurgical research. And well it might be for nitrided steels are fast becoming indispensable to industry.

Nitriding is a comparatively simple process in which special steels are exposed to the action of ammonia gas at temperatures sufficiently high to cause the breaking down of the ammonia and absorption of the nascent nitrogen. The simplicity of the process is indicated by the method: within the furnace the steel to be treated is placed in a slowly moving stream of ammonia gas. The ammonia is the same that is commonly used in refrigeration, and disposition of waste gases from the process presents no problem.

Hardness and toughness in steel have in the past been obtained by subjecting low carbon steel to the action of a carburizing material. The carbon penetrates the surface layer, changing that part into high carbon steel, while the core remains low in carbon content. This process is not only somewhat cumbersome, but the heat treatment which must follow carburizing is quite likely to cause warping or distortion. The nitriding process gives all the benefits of the carburizing method without any of its disadvantages. Steel treated by nitriding is free of distortion and its surface is harder than that produced by older methods.

Nitriding is now being widely employed in the manufacture of automobile parts, including the gears, which are subject to constant wear, steering-gear parts, and the like. The hard surface of nitrided steel is also valuable in producing highly accurate gauges.

Although metallurgists have known something of the effects of nitrogen in iron and steel for nearly a century, it was not until 1916, that Dr. A. Fry, distinguished worker in metallurgy, after long research in the Krupp Works at Essen, first suggested nitriding as a commercial process. Further investigations in America and in France have developed the process to a high degree of commercial value.

The temperature to which steel is subjected in nitriding is comparatively low. This fact permits heat treatment of the metal before the hardening process without danger of changing the desirable physical characteristics. The temperatures in nitriding range from 900 to 1,000° F. but the temperature most commonly employed in commercial practice is 975° F. The time required for nitriding ranges from two to 90 hours, depending upon the depth of surface hardness desired.

New Metals for Old

METALLURGISTS are responsible for some of the most dramatic achievements of present-day science, although in the public mind they are largely unwept, unhonored, and unsung. The nitriding process (see page 140), the development of welding for ships and buildings, the new Aston process for making wrought iron cheaply, the new stainless steel and chromium alloys that adorn automobiles, furniture, and buildings — these are contributions from their laboratories.

It is they, also, who are making known how unfamiliar metals such as tantalum may be used advantageously. This metallic element, belonging to a family of three metals which includes vanadium and columbium, had its first successful application as a filament for the incandescent light. For this use it has yielded to tungsten, but many other uses are being found for it, particularly in the field of industrial chemistry. Here its corrosion-resistivity and strength render it serviceable for agitators, for laboratory ware (replacing for some uses the more expensive platinum), and for spinnerets in the rayon industry. It is also being used as a lining for autoclaves and acid towers.

Tantalum is exceptionally ductile when cold worked and may be hammered, rolled, machined, drawn, spun and punched into various forms. It is readily welded either to itself or to other metals and is not affected by hydrochloric or nitric acids, by organic acids, or even by aqua regia.

Its limitations include its susceptibility to hydrofluoric acid, the necessity of not heating it in air, and its inability to be worked when hot. It freely absorbs common gases such as hydrogen, oxygen, and nitrogen at moderately high temperatures, although these gases, once absorbed, may be driven out by heating the metal in a vacuum.

Radio Traffic Cop

TRAFFIC congestion is not alone a problem of the highways of the earth, for with the swift development of wireless communication space is filled with the flying impulses from a multitude of commercial and broadcasting stations. As Mr. H. B. Richmond, '14, describes at length in the first article of this issue, the Government has undertaken to chart the heavens and assign various wave channels to limit the operation of various types of stations for the benefit of all.

Development of crystal control of frequencies assigned to individual stations was a great step toward order in the ether, but with approximately 20,000 radio stations of various classes in operation it is now more than ever necessary to make sure that the various units are operating on their assigned frequencies.

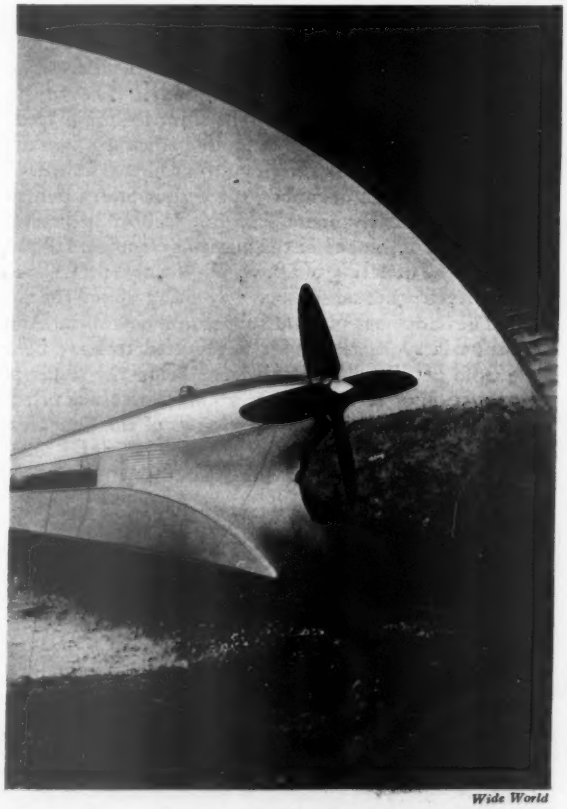
Now the United States Department of Commerce, of which the Radio Commission is a part, is building a great monitoring station at Grand Island, Neb., at approximately the geographical center of the country. Here a group of scientific radio traffic police will undertake to study the signals of the country's radio stations and take what action may be necessary to stop speeding, passing on curves, or misusing one-way thoroughfares.

At this great traffic control station, which will represent an expenditure of at least $1,000,000, government engineers will check the power and the frequency of every station. This plan represents the Radio Commission's first comprehensive attempt to bring radio traffic under rigid control. The new station will coöperate with the Berne Bureau in Switzerland in checking the operation of foreign stations. Beyond its function as a regulatory force, the new station will in the very nature of its work carry on research from which may come a more complete understanding of the science of wireless communication and, perchance, a solution of some of the natural obstacles that at times make such communication difficult.

New Facts about Rubber

THE innumerable uses for which rubber has been adapted within the past twenty years have far exceeded the most fantastic dreams of the early workers in an industry that is now one of the most important in the world. Nor is the end in sight. New uses for rubber are being found almost daily and, while the world's supply still comes from the rubber tree, science is making a significant search for new sources of this most adaptable substance.

Perhaps the most striking recent development in the rubber industry is the application of latex, the sap of the rubber tree in its raw form, in an entirely new field of



Wide World

THIS AIR-RAIL CAR, IN LENGTH 85 FEET, DRIVEN BY A 400-HORSEPOWER AIRPLANE MOTOR WITH A PROPELLER HAS BEEN OPERATED AT 100 MILES PER HOUR NEAR HANOVER, GERMANY

Courtesy Boston Evening Transcript

ONE OF SIX NEW ONES: NANTUCKET LIGHTSHIP LOCATED 200 MILES EAST OF NEW YORK WHERE IT SERVES AS A BEACON FOR TRANSATLANTIC SHIPPING

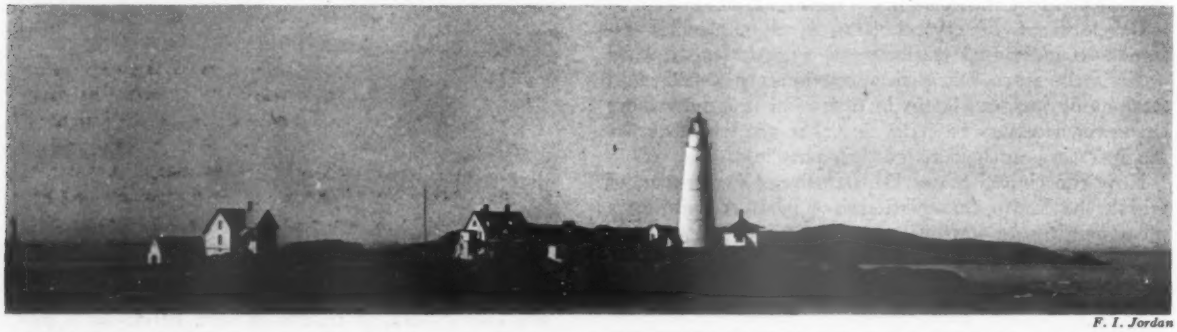
usefulness (see November Review). In this respect, however, the modern rubber technologist is rediscovering an old secret, for in 1615, according to records of the explorations of one F. Juan de Torquemanda, the natives of Mexico and Brazil were making waterproof hats, garments, shoes, and even boats by impregnating various materials with the "milk-sap of a tree growing in the Amazonas." Latex is again being used for waterproofing textiles and for various other purposes. As for rubber footwear, the forerunner of the modern galosh was the crude rubber shoe of the natives of Brazil. They made clay casts of their feet, dipped the form in liquid latex over and over again until the required thickness was attained, and then crushed the clay form to leave a shoe.

As for new sources of rubber, the United States Bureau of Standards recently announced that rubber in crystal form has been developed in the bureau's chemical laboratory under the direction of Dr. E. W. Washburn, '05, (see October Review). Such rubber may bring about the industrial development of solid rubber in a new form. And in California synthetic rubber is reported to have been made from petroleum, the substance being the result of the extraction of certain hydrocarbons from crude oil.

Scratching around in the desert sands of the Caucasus, Russia has discovered that the sap of a perennial plant called kondrilla contains a high percentage of rubber, and that rubber may also be extracted from the tausagyz plant. Factories are being built and the Russian government expects to produce 2,000 tons of rubber from kondrilla alone this year. Experiments are also being carried on in Russia to determine whether the Mexican guayule plant, which also contains rubber, can be grown in the land of the Soviets. Development of Russian sources of rubber, however, is said to be progressing. Little adequate research is being carried on there, however, and actual production is still prohibitively expensive.

Rubber already has done much to reduce noise, and its further usefulness for that purpose is indicated in experiments in England and Scotland, where rubber bricks have been used for paving streets. A rubber block pavement laid in one of Glasgow's busiest streets in 1923 is still giving satisfactory service and shows little wear. The blocks of rubber used were nine inches long, four and a half inches wide, and one and a half inches thick, and were laid on a concrete base. Rubber bricks laid in one of London's most traveled thoroughfares in 1926 have borne an extraordinary traffic load with a replacement rate of only 14% in three years. The only defects in the bricks replaced were slight blisters and peeling of a thin surface layer.

With all the progress made in the industrial development of rubber, much remains to be done in research which will throw new light on existing processes, many of which are empirical. The *Industrial Bulletin* of Arthur D. Little, Inc., directs attention to the need for more complete knowledge of the effects of the so-called "softners" which play a vital part in rubber manufacture. Among these organic substances are steric acid and pine tar, both of which are important in making the rubber for the tread of automobile tires. Softners are employed to control the manufacture of rubber at various stages, to permit higher loading with fillers, to increase the speed of manufacture in mixing, extruding or moulding, to promote or reduce adhesive properties, to give improved electrical waterproofing and airtight properties besides various other changes. The general effect of these softners is known, but their actions have not been classified to establish a relative order of merit for the specific effects desired.



F. I. Jordan

IN OCTOBER LIGHTHOUSE EXPERTS OF THE WORLD MET IN LISBON FOR AN INTERNATIONAL CONFERENCE ON UNIFICATION OF BUOYAGE AND LIGHTING OF COASTS

BOOKS

Scientific Book Club Selections

BY special arrangement with the Scientific Book Club, Inc., the Review is to present each month the books selected by that body as meriting the careful attention of all who desire to keep abreast of scientific thought. The selections are made by an editorial committee consisting of Arthur H. Compton, Edwin G. Conklin, Kirtley F. Mather, Harlan T. Stetson, and Edward L. Thorndike.

For November the principal selection was:

THE MYSTERIOUS UNIVERSE, by Sir James Jeans. $2.25. 160 pages. Illustrated. New York: *The Scientific Book Club, Inc.*

Other highly recommended books are:

PHYSIQUE AND INTELLECT, by Donald G. Paterson. $2.50. 290 pages. Illustrated.

THE ADVENTURE OF SCIENCE, by Benjamin Ginsburg. $5.00. 465 pages. Illustrated.

EXPERIMENTAL CHEMISTRY, by A. Frederick Collins. $2.00. 274 pages. Illustrated.

Conquering Disease

RIDERS OF THE PLAGUES, by James A. Tobey. $3.50. vii + 348 pages. New York: *Charles Scribner's Sons.*

IN THE latest of his many books relating to public health, Dr. Tobey has provided a volume portraying the lives and accomplishments of leaders in the public health movement. The success of such books as "Microbe Hunters" and "Hunger Fighters" and several biographies of the Health Heroes (for boys and girls in their teens) has already demonstrated a public interest in this subject. Stories such as these have a triple appeal, for we are interested in health, in human progress, and in biography. "Riders of the Plagues" uses biography as the enjoyable vehicle for presenting many interesting facts concerning both public health and social progress.

We have here a portrayal of man's rise from ignorance, fear, and superstition as indicated by his attitude toward disease. Gradually the accumulation of scientific knowledge has supplanted priestcraft doctors and barber surgeons with the splendid science of curative medicine. Similarly, the science of public health, or disease prevention, quite distinct from the treatment of diseases, has built its own technology with the development of Public Health Laboratory Technique, Epidemiology, Vital Statistics, Sanitary Engineering, and associated fields of knowledge. Clearly public health is not a mere phase of medical science, for we find among the foremost leaders in the battle to prevent disease, such people as Chadwick, the lawyer; Shattuck, the statistician; Florence Nightingale, the nurse; and Sedgwick, the epidemiologist and teacher. Pasteur, the greatest hero in the whole long list, was a chemist.

The book begins with a story of the great plagues in the past. Disease is frequently seen as a determining factor in war, and in the migration of races as well as in the development of religious and national customs. The pestilences of antiquity, Saint Anthony's Fire, the Black Death, the Dancing Sickness, and Jail Fever, are described. The first Board of Health appears in Venice in 1348, establishing and naming the first "quarantine," a period of forty days "for no scientific reason but that that was the duration of Christ's stay in the desert." Sanitation began in the days of Imhotep and Ptolemy, of Hypocrates and Galen, of Moses and Asoka. Sanitary Engineering of real merit contributed to the grandeur of Rome, but the sanitary standards of the Middle Ages were seriously lowered.

The Eighteenth Century shows some significant beginnings. In 1720, Dr. Meade writes on pestilential contagion. Twenty-five years later John Wesley, the clergyman, writes on "Primitive Physick." In 1767 Dr. Baker demonstrates lead poisoning in Devonshire cider. In 1771 Captain Cook shows how to prevent scurvy. In 1796 Dr. Jenner develops small pox vaccination. But by the middle of the Nineteenth Century things really begin to happen. Mr. Chadwick's studies result in the creation of the first General Board of Health in England. Dr. Snow proves the spread of disease by polluted water and Mr. Shattuck in Massachusetts prepares the report which is thought by some to be the most remarkable document in the history of public health.

At this point the author devotes a chapter to each of six outstanding figures in public health. First appears Pasteur who made public health a science through his discovery of microbes, germ diseases of silk worms, anthrax vaccination, and the treatment of rabies. Florence Nightingale, the Lady of the Lamp, saves thousands of lives in the Crimean War, and lays the foundation for the development of the nursing profession which today number in the United States alone, 20,000 Public Health Nurses, 200,000 Registered Nurses, and 150,000 so-called Practical Nurses. Around Joseph Lister is built the story of the emergence of modern sanitary surgery from the primitive surgery of the remote past and the terrible conditions of wide-spread infection in connection with the surgery just preceding our knowledge of germs. The story of Walter Reed, and his associates, reveals man's conquest of the mosquito-borne diseases. The Story of Trudeau shows our struggle against that ancient foe of man, tuberculosis.

A chapter of special interest to many of the readers of this magazine deals with the work of Professor William Thompson Sedgwick, who is spoken of as the foremost exponent of sanitary science during the last twenty-five years of his life. Under Sedgwick's leadership "it was not a medical school, but an engineering institution which took the initiative in offering the first real instruction in public health, in this country . . . and more trained sanitarians have so far been bestowed upon the United States by this same school of engineering than by all the other medical schools of public health combined." His work in the typhoid epidemic of Lowell and Lawrence in

1890 has caused him to be called the father of epidemiology. His work at the Lawrence Experiment Station with Professor Drown, Mr. Mills and a group of young students at the Institute, including George W. Fuller, W. O. Gordan, Gary N. Calkins, X. H. Goodnough, the late Allen Hazen, and others, laid the foundation for American sewage disposal practice. A station for the study of water purification was established at Chestnut Hill, in charge of George C. Whipple who later became a Sanitary Engineer of national reputation. It was the suggestion of Mr. Whipple, then a Professor at Harvard University, which resulted in the creation of the School for Health Officers, which was conducted jointly by the Massachusetts Institute of Technology and the Harvard Medical School from 1913 to 1922. Professor Sedgwick was instrumental in bringing about this coöperation and served as Chairman of the Administrative Board of this School, which operated without special endowment for teaching or for scholarship grants, and which trained nearly two hundred men and women. He was the first President of the American Bacteriological Society and an advisor in public health administration to the State of Massachusetts, the Rockefeller Foundation, and the National Government. His place and services as a teacher illustrate the fact that it is men and not buildings which make a university or school. Splendid tribute is paid to Chapin, Vaughan, Biggs, Winslow and other contemporaries.

The remaining chapters, dealing with nutrition and the problem of further improving the quality of health and at the same time further extending the span of life, show us that the great fields of scientific discovery in the realm of health with their potential services to mankind are still before us.

The story moves rapidly and the style of the straight narrative is excellent. The tone of the book is wholesome and optimistic; yet in a few places one feels that the humor is forced. No two authors would give the same relative values to men and incidents, but Dr. Tobey's perspective is broad and sound. It is safe to say that all who read the book will feel well repaid for the investment of reading time.

CLAIR E. TURNER

A History of Humanity

A HISTORY OF SCIENCE AND ITS RELATIONS WITH PHILOSOPHY AND RELIGION, by William C. D. Dampier-Whetham. $4.00. xxi + 514 pages. New York: *The Macmillan Company*.

IF SCIENCE is positive knowledge, a history of science is a history of the intellectual activity of man. If knowledge is considered in its relations with philosophy and religion, then a history of that knowledge is a history of human culture. One recent thinker has said that it is the business of science to supply beliefs for the mind to accept, and the business of religion (and philosophy) to give us something for the heart to cling to. In the light of this distinction it is interesting to inquire into the status of the conflict between science and religion. But the point we wish here to emphasize is that science and religion (and philosophy) defined in this way constitute between them the very essence of humanity. Another recent thinker has said that science seeks to discover what is, while religion and philosophy seek to discover whatever is to be done about it. As our knowledge of the universe improves, our reaction to it alters. So again, our knowledge plus our reaction to our knowledge, these two taken together constitute us — and a history of them is a history of humanity in its broadest sense. A knowledge of such history — of man, the measure, the measurer, and the measured — is the only genuine basis of humanism.

A history of science and its relations with philosophy and religion, being a history of the life of mankind, presupposes some acquaintance with the conditions which have determined the mode of that life, that is, with political history and a small amount of such material inevitably appears in the present book. There is enough for its significance to be clear. The book is cordially recommended to those who think that political history is history. And it is recommended to persons of congenital culture, who will find in it much to weigh and to consider. A few interesting passages follow:

"Platonism in its various forms was left to represent Greek thought to later ages, a fact which was one of the reasons why the scientific spirit vanished from the earth for a thousand years. Plato was a great philosopher, but in the history of experimental science he must be counted a disaster."

"In religion, and in social and political structure, we are still akin to the Middle Ages from which we have so recently emerged; but in science we are nearer to the ancient world. As we look back across the mist-filled hollow, we see the hills behind more clearly than the nearer intervening ground, illumined only by the 'dim light of scholasticism and theology.'"

"Even physicists had lost touch so entirely with philosophy that when in 1883 attention was called by Ernst Mach to the philosophical basis of mechanics, his work was ignored by some, slighted as fanciful by others, and overestimated for originality by the few who studied and appreciated it."

Dampier-Whetham's book is probably the best one-volume history of science which has appeared within recent years, but for all that, it is not an adequate treatment of the subject. It does indeed show the working out through the ages of many tendencies of mind. To one who is not familiar with the history of science, it will open new vistas and will serve as an introduction to the history of humanity. To one who is already familiar with the subject, it will also be of value and interest. The account of the history of philosophy is especially good, and shows that science and philosophy are inextricably connected. Knowledge advances by their interplay.

The treatment of the history of chemistry is far from satisfactory. The fictitious Basil Valentine is spoken of as if he really existed. No mention is made of the fact that "the Swiss alchemist and quack doctor," Paracelsus, introduced opium and mercury into European medicine. Boyle "is chiefly remembered for his discovery that the volume of a given quantity of air is inversely proportional to the pressure, and for the Irish epitaph in which, it is said, he was described as the Father of Chemistry and Uncle of the Earl of Cork. He was also a philosopher of a very moderate, pleasing and English variety." The names of Willstätter and Haber do not appear in the index. Berthelot is mentioned only in (*Concluded on page 166*)

Physics and Chemistry Building

LAST July The Review recorded President Compton's hope for a new physics and chemistry building at an early date. Happily that date is at hand, and construction is to begin immediately. Funds for starting the building, which will join two wings of the present buildings on the east side of the main Technology educational group, are available from the gift of $2,500,000 donated by Mr. George Eastman in 1916, as a supplementary fund for additional educational buildings, when needed.

The new structure will be over 300 feet long, 60 feet wide and will contain four stories, plus basement. It will include a well-equipped shop for the construction and maintenance of the delicate instruments used in research; a spacious lecture room; and a joint library and reading room for the use of the staff and students in physics and chemistry. The research rooms have been designed to permit the greatest flexibility in arrangements for future requirements. The construction specifications call for a structure of unusual rigidity with foundations of heavy reinforced concrete to aid in eliminating vibration, a necessary requirement because of the exacting standards of research in this field.

THOMAS P. PITRÉ, WHO BECAME ACTING ASSISTANT DEAN ON NOVEMBER 7

The importance of spectroscopy in the study of atomic and molecular structure which in the next decade seems certain to become the most important agency in chemical research, is recognized in plans for an additional separate spectroscopic laboratory to be housed in a building which will occupy a site in the quadrangle formed by the new physics building. The construction of the spectroscopic laboratory presents features which have called for engineering rather than architectural design. The two floors of this laboratory will be supported on a foundation of unique design which will be entirely separate from that of the outer walls and the roof of the building. This foundation is to be more than three feet thick, and composed of alternate layers of sand, felt, transite board, ground cork, and reinforced concrete. These elaborate precautions are expected to entirely eliminate shocks and vibration from industrial processes in the neighborhood and the movement of traffic on adjacent highways.

The spectroscopic laboratory will be 100 feet long and 60 feet wide, and in addition to the extraordinary precautions to eliminate vibration, provisions will be made for maintaining extreme constancy of temperature. The equipment of the laboratory includes a collection of the finest instruments which have been gathered at Leland-Stanford University by Professor George R. Harrison, who this year joined the staff of Technology as Director of the Research Laboratory of Experimental Physics.

In addition to the proposed physics and chemistry building, plans for a cryogenic laboratory for fundamental studies in the science of low temperatures are under consideration. These plans provide for a laboratory with the most advanced facilities for this type of research, with plants for the production of liquid nitrogen, hydrogen and helium. Such a laboratory will place Technology in a unique position in America for carrying on important physical and chemical investigations.

The main physics building is being designed by the architectural firm of Coolidge and Carlson (Harry J. Carlson, '92), and the spectroscopic laboratory by the engineering firm of Charles T. Main (Charles T. Main, '76, Charles R. Main,' 09), Inc.

Acting Assistant Dean

APPOINTMENT of Thomas P. Pitré as Acting Assistant Dean was announced by President Compton on November 7. This appointment, which became effective on that day, was made in recognition of the growing importance of the services of the Dean's Office, and to meet the requirements of Technology's increase in Freshman enrollment.

In addition to his duties as Chemistry Instructor, Mr. Pitré has been in charge of freshman registration for the past two years. In this work he has been closely in touch with Dean Harold E. Lobdell, '17, and therefore has had much valuable experience with first year students.

Mr. Pitré was graduated from Amherst in 1919, and from that time until 1920 he was a teacher at Phillips Andover. In 1920, he was appointed to the teaching staff of Technology as an Instructor in Chemistry, which position he will continue to fill as well as that of Acting Assistant Dean.

Presidential Report

NOTABLE in content was the annual presidential report covering the academic year 1929–1930 which Dr. Stratton presented to the Corporation this fall. The report surveys the activities of Technology during the closing year of Dr. Stratton's presidency. It likewise

contains plans for the future which Dr. Stratton, as Chairman of the Corporation, and Dr. Compton, as President, expect to complete during oncoming years.

Dr. Stratton commended the Department of Hygiene and pointed out the justification for the required physical examinations for all students which until two years ago was required for freshmen only (See The Technology Review, December, 1928).

Two important new subjects will be offered at Technology this year designed to train men in geodesy and seismology. The former subject, one already undertaken in the Department of Civil Engineering, will be expanded to include vital study of the earth's movements. The work in seismology, the science of earthquakes, is instituted to develop new knowledge on the effects of earthquakes on engineering structures.

In calling attention to the demand for graduates of the Department of Mechanical Engineering, he reported that all seniors and graduate students of last year had secured positions before their graduation and that 50% more could have been placed had they been available. The work of the Testing Materials Laboratory has expanded and new equipment has been installed. The Textile Laboratory has also developed rapidly, and it is busy with important research. Dr. Stratton noted the growing importance of metallurgy and how the work of metallurgical engineers in recent years has revolutionized a number of industries. The demand for experts in this field exceeds the number it has been possible to train, and the Institute's registration of students pursuing metallurgical work has increased. The Department of Mining and Metallurgy is not only training men for this profession, but it is also carrying on research of major importance.

Other items of interest to Alumni include: 1. The success of Course XVII, Building Construction. Besides its emphasis in fundamental science and engineering, this course gives training in construction methods, assembly of materials, the relation between the architect and the engineer, and the most efficient utilization of labor; 2. The growing value of the new Hydraulic Engineering Laboratory, established during the past year. The studies that are carried on in this Laboratory include harbor control, dam construction, power development, turbines, rotary pumps, propellers, and so forth; 3. The wide interest aroused by the Department of Fuel and Gas Engineering organized several years ago; 4. The creation, as announced in The Review last July, of the Course in Business and Engineering Administration, separate from the Department of Economics and Statistics; 5. The success attending the work of the new Course in Meteorology established two years ago.

The 147th Alumni Council Meeting

EIGHTY-THREE members and guests were present in the North Hall of Walker Memorial on the evening of October 27 for one of the largest meetings of the Alumni Council ever held including the now celebrated 100th Meeting whereat Walter Humphreys, '97, received a watch, and the Alumni, indigestion.

The major item on the program of the 147th Meeting was the introduction of Dr. Compton and the address by him on Alumni Relations. Dr. Compton outlined the most pressing needs of the Institute—notably, higher salaries for its Staff, more space for laboratory and instructional work, a dormitory for graduate students, and an enlargement of Walker Memorial, the student social center (see plans in the May, 1930, Review). He compared the educational process of the Institute to an industrial process wherein it is first necessary to acquire raw material, then to manufacture it into a finished product, and finally to sell it in a ready market. He pointed out how essential it was that there be no obstruction to this flow of material, and he enumerated the ways in which Alumni could help in obtaining the best raw material, how they might suggest better means of educating it at the Institute, and finally how much they could aid in placing it. He stressed the Institute's need for more publicity and said that two moves were necessary to obtain this end: (1) larger publicity service at the Institute and (2) more activity on the part of Alumni. The most valuable publicity, of course, is the success of the Alumni themselves.

He further discussed the possibilities of colleges extending their educational process to include the Alumni. Amherst, for instance, a number of years ago put such a plan into operation, and many other colleges have attempted some form of adult or Alumni education. Princeton for a short period mailed out a series of lectures to its Alumni. Dr. Compton was dubious about the success of any of the plans yet developed, but he expressed the opinion that The Technology Review here at the Institute was serving admirably as a means of keeping the Alumni informed in their special fields.

Donald G. Robbins, '07, presided in the place of Thomas C. Desmond, '09, whose campaign for State Senator in the State of New York precluded his being present —an absence upon which the Council stamps approval since later advices have indicated that Mr. Desmond won. Vice-President Robbins introduced the new members of the Council who were present at the dinner. These included: John C. Damon, '05, Representative of the Technology Club of Kentucky, at Louisville; Arthur Winslow, '81, Class Representative; Gorham Dana, '91, Class Representative; Eben B. Haskell, '26, Class Representative; Harold P. Champlain, '31, President of the Senior Class. The following new members of the Council whose names were called were not present: Willard W. Dow, '01, Representative of the Technology Association of Minnesota at Minneapolis; James I. Banash, '06, W. Rawson Collier, '00, Robert J. Marlow, '17, Burt R. Rickards, '99, and Carl J. Trauerman, '07,—all Representatives-at-Large. During the salad course, Vice-President Robbins also introduced Richard H. Ranger, '11, who was present as a representative of The Technology Club of New York. Mr. Ranger spoke briefly about the activity of his Club and about the possibility of instituting a series of lectures there by Technology professors.

The first item in the business meeting was the presentation of the report of the Secretary. Professor Charles E. Locke, '96, Secretary, was absent because of sickness, and for him J. Rhyne Killian, Jr., '26, presented the report of the Executive Committee meeting which had convened at 5:00 P.M. preceding the Council meeting.

In accordance with a recommendation of the Executive Committee, it was moved, seconded, and passed by the Council that the Vice-President appoint a committee

Photograph by Peter A. Juley & Sons from a painting by H. C. Christy

T. COLEMAN DUPONT, '84, INSTITUTE BENEFACTOR, LIFE MEMBER OF ITS CORPORATION, AND FORMER PRESIDENT OF THE ALUMNI ASSOCIATION, WHO DIED ON NOVEMBER 11

from the Alumni Council to make recommendations on suitable inscriptions for the new dormitories to classes and individuals who contributed to the dormitory fund. In accordance with this vote Vice-President Robbins named the following committee: Samuel C. Prescott, '94, Chairman; Thomas B. Booth, '95; and Gorton James, '10.

The next item on the agenda was a progress report of the committee on a new method of electing Term Members on the Corporation, and this was presented by Dr. Allan W. Rowe, '01. He reported that his committee likewise was moving toward a complete revision of the Association's Constitution — a revision, of course, made necessary by the new term membership plan.

In accordance with a custom long adhered to, the Secretary had invited to the Council meeting the members of the Corporation whose terms expired at the end of the last fiscal year, and the new members of the Corporation elected by the Alumni to replace them. Of the three retiring members, Salmon W. Wilder, '91, was present, and Vice-President Robbins called upon him for a word of greeting to the new Corporation members. Mr. Wilder spoke briefly of the pleasure he derived from being a member of the Corporation and of the great opportunities it presented for association with able men interested in the Institute.

Of the new members of the Corporation, Godfrey L. Cabot, '81, was present, and he expressed his wish to be able to pull his "load in the boat" as a member of the Corporation.

Dr. Allan W. Rowe, '01, next presented two more reports. The first, a report of the Committee to Nominate Members of the Advisory Councils for Undergraduate Activities. This Committee had names to present at this time because of the action taken last May in increasing the size of these committees. The names he presented for membership on these committees are as follows: Walter J. Hamburger, '21, Advisory Council on Tech Show, until 1932; Harold S. Wilkins, '14, Advisory Council on Boat House, replacing William B. Thomas, '29, resigned, until 1932; and J. Rhyne Killian, Jr., '26, Advisory Council on Undergraduate Publications, until 1933.

The second report presented by Dr. Rowe was the report of the Committee on Audit and Budget. He stated that the Auditors, Patterson, Teele and Dennis had made their annual investigation of the Association's books and found them in good condition.

He further stated that as Chairman of the Committee on Audit and Budget he had looked over the report of the Treasurer covering the operations of the Association for the past six years, and had noted in that report the contributions made by The Technology Review to the financial well-being of the Association. During a period of six years, The Review had turned over in profits to the Alumni Association more than $29,000. He pointed out that the Executive Committee two years ago had moved to set aside a portion of The Review profits in an endowment fund known as The Technology Review Fund, and placed in the custody of the Committee on Permanent Funds. He then recommended that this policy of placing a portion of The Review profits in The Technology Review Fund be continued.

Vice-President Robbins placed this later recommendation of Dr. Rowe's before the Council, and it was voted that it was the sentiment of the Council that a portion of

The Review profits be placed in The Technology Review Fund under the custody of the Committee on Permanent Funds.

Vice-President Robbins next introduced to the Alumni Council the following new Faculty members: John C. Slater, the new Head of the Department of Physics, George R. Harrison, Professor of Physics, R. M. Langer, Assistant Professor of Physics. Dr. Samuel W. Stratton, Chairman of the Corporation, was presented to the Council. He spoke briefly about his appreciation of the coöperation that the Alumni gave him at all times.

The Honors Group Plan Report

ONE of the pioneer efforts in American engineering education to provide exceptionally able students with greater opportunity for exercise of originality and vision was authorized by the Faculty for trial in the Department of Electrical Engineering beginning with the fall of 1925. The first formal report of the Department's experience, made recently to the President and Faculty, is of considerable interest.

According to the report, the plan developed by the Department (a description of this plan appeared in the January 1929 issue of The Review under the title, *Honors Study in Engineering*) aims to provide an independent atmosphere of work designed to stimulate an attitude of intellectual courage and resourcefulness in students of appropriate mental capacity and personal qualifications. The honors students have done notable work under the arrangement, and have in a large measure developed those qualities which the plan aims to instill. The interesting feature of the academic records of these students is that in general a marked upward trend is shown during the two year period of honors study as compared with the records of other electrical engineering students during the same period or as compared with the records of the honors students prior to their period of honors study. However, the reason that the records are gratifying is not on account of their excellence alone, but primarily because they were earned so largely by independent work.

The total number who have been graduated as honors students now numbers 87. Since the first of these have been graduated but a few years, and since a large number have continued in graduate work, it is rather early to make a study of their accomplishments in their subsequent occupations. A study of this sort is contemplated when the time seems appropriate. However, a number of cases of notable accomplishment already have come to the attention of the Department. Each year, fellowships established by Gerard Swope, '95, for the purpose of encouraging graduate study have been awarded the two senior honors students of highest standing (a third Swope Fellowship is awarded in Physics).

The plan now is in its sixth year of operation with 21 honors students in the junior and senior years. They are: Charles B. Basinger, Kenneth R. Bolles, Gordon S. Brown, Alfred L. Dowden, Kenneth J. Germeshausen, David M. Goodman, Davis D. Lewis, Samuel B. Pritchard, Howard L. Richardson, Michael G. Rogers, and Donald B. Sinclair, all of the Class of 1931, and Henry S. Duncan, John C. Gibson, Milton S. Hathaway, Frank M. Ikuno, William R. Power, Jr., John Cecil Rowe. Elwood W. Schafer, Thomas R. Smith, Harold A. Traver, Herbert M. Wagner, and Fred D. Williams, Jr., all of the Class of 1932.

Following the presentation of the Department's report, stating the progress of the work, the Faculty voted to authorize the Department to incorporate the Honors Group Plan as a permanent part of its educational process and to permit other departments to adopt similar plans should they so desire. The Electrical Engineering Department therefore is continuing to develop its plan along the lines already laid down and endeavoring to render the functioning of the plan more and more effective. The object of immediate study is the status of the comprehensive examination given to honors students near the end of the senior year. Last spring, with permission of the Faculty, the comprehensive examination was for the first time made a requirement and administered by outside examiners invited from industry: Ernest E. Johnson, of the General Electric Company, Timothy E. Shea, '19, of the Bell Telephone Laboratories, Incorporated, Hugh H. Spencer, '23, of the New England Power Construction Company, and Herbert R. Stewart, '24, of the Westinghouse Electric and Manufacturing Company. The results of this examination were very interesting and very useful as a gage of the effectiveness of the plan and as a basis for the improvement of future examination procedure.

The workings of the plan are being studied by other departments of the Institute and by other engineering schools. Future reports of the Department of Electrical Engineering upon this subject will be anticipated with interest.

Deaths

WITHIN a fortnight last month death removed two men who have played major roles in the history of the Institute: Frederick P. Fish, a Life Member of the Corporation since 1902, and from that date to 1926 a member of its Executive Committee; and T. Coleman duPont, '84, a Corporation member since 1906 (Life Member 1911–30), and President of the Alumni Association during the year 1919–1930.

Mr. Fish, who died November 6, was a distinguished lawyer and business man, having been President of the American Telephone and Telegraph Company for many years. He was particularly interested in the Department of Electrical Engineering, being a member of the Visiting Committee of that department from 1902 to 1911. After he retired from the Executive Committee, he became a member of the Visiting Committee of the Department of Physics and of the Membership Committee of the Corporation.

Mr. duPont, who died on November 11, besides giving greatly of his time to the Institute, gave more than a million dollars, it being his gift that made possible the purchase of the land upon which the Institute now stands. One of America's great business leaders, he made a fortune in mining, and later when 39 years old accepted the Presidency of the E. I. duPont de Nemours and Company, placing that company in its present commanding position. He was Senator from Delaware from 1921 to 1922 and from 1925 to 1928. In a forthcoming issue The Review is to publish an extensive account of his career.

MAKING MAPS FROM THE AIR

(*Continued from page 130*)

of 12-inch focal length at 10,000 feet altitude produces a usable area from each photograph of about 0.65 square miles, at a scale of about 830 feet to the inch. So multiple-lens cameras have been perfected and one four-lens instrument under the above conditions gives a usable area for mapping purposes of 4.0 square miles for each simultaneous exposure of the four negatives at a scale of about 1,500 feet to the inch. The single lens camera cuts a swath of 1.4 miles in width per flight strip; the four-lens camera, one of 6.2 miles. Thus an economy in flying time is effected. One exposure is taken vertically, the other three are oblique shots and they must be "transformed" or rectified before being used in map compilation. This, however, is easily accomplished in a special printing device. Photographs from a multi-lens camera are seldom used for making mosaic maps although they can be. Generally they are used after rectification to compile line maps by the radial line method.

The equipment of the expedition of the U. S. Navy in 1929 to map 13,000 square miles of Southeastern Alaska gives an idea of a large-scale application of the procedure above outlined. Four amphibians with Pratt and Whitney Wasp engines were used: two for mapping, one for oblique photography, and a fourth as reserve in case of emergency. On the expedition it is estimated that all the planes flew 677.40 hours and totalled 54,182 miles. On mapping flights, they flew over 19,436 miles in 242.95 hours and this they accomplished though rain fell 75 days out of the 104 spent in Alaska. Under such conditions it was found that a multiple-lens camera was valuable.

In each mapping plane there was a personnel of three: the pilot, the navigator, and the photographer. The work was carried on from an altitude of 10,900 feet in atmospheric conditions that varied from −6° to +40° F., the photographer being taxed with the necessity of making exposures often enough to allow for a 70% directional overlap. This was made particularly difficult because of the irregular topography of the Alaskan Panhandle where the elevation of the terrain varies from zero at sea level to 8,000 feet. Such variations made it necessary to watch carefully the interval between exposures, the shortest used being seven seconds and the longest, 32 seconds. But with the aid of the view finders used with the cameras, the 70% directional overlap was made possible in spite of the apparent difficulties.

Before each mapping flight was attempted, a careful analysis was made of the charted area, using the best available charts — preferably those of the U. S. Coast and Geodetic Survey to the scale of 1–200,000 or of the International Boundary Commission to the scale of 1–250,000. Flight lines were drawn 4½ miles apart and where possible at right angles to the shore line. The spacing of 4½ miles was to allow for lateral overlap of 30%.

Since the Alaskan Expedition, the Army Air Corps and Fairchild have developed a five-lens camera, taking one vertical and four oblique photographs.

In Canada, where aerial surveying methods have been extensively developed, the practice is to compile line maps from either vertical or oblique photographs without assembling the actual photographs into a "mosaic" at all.

When vertical photographs are used the Canadians employ what is known as the radial line method. Briefly, it consists of locating all features desired for the map by means of intersecting lines. Every point is common to at least two and often more photographs. This being true, it is possible by intersecting lines to establish various traverses corresponding to the various strips of photographs and accurately locate every physical feature shown in the photograph.

In the oblique method, as used in Canada, the optical axis of the camera is depressed at an angle approximately 17 degrees from the horizontal. The plane usually flies at an altitude of 5,000 feet; one photograph is taken straight ahead; the camera is immediately turned through an angle of 45 degrees to the right and another photograph taken; and then to 45 degrees to the left of the line of flight and a third photograph is taken. As can be seen from the photo on page 130, these three views overlap slightly. Three more views are taken in exactly the same manner after the airplane has advanced approximately 2½ miles along its flight course.

Of course, the resulting photographs show the ground in perspective and cannot be used for mapping purposes without first correcting for perspective. This is done by ruling a grid in a perspective corresponding to the photography and then laying off a coördinate sheet to the proper scale. (*See illustrations on pages 128, 129, 130.*) If the perspective grid is on a transparent substance like glass or celluloid it may be laid over a photograph and the physical features shown in the photograph transferred to the coördinate sheet square by square. The various areas covered by the individual photographs are then assembled on strip sheets and the strip sheets assembled into maps covering the desired area or into atlas sheets of a predetermined size. During the process of transferring to strips the detail is coördinated with ground control points which are located either by astronomical observation, stadia surveying, or triangulation. In this way the resulting map is kept within the desired limits of accuracy.

The oblique method has the advantage of requiring a relatively small amount of field work and, therefore, is inexpensive compared with vertical surveying. However, it is not so accurate and can be used only in flat country. In Canada it is used in the low regions where the mean variations in altitude are not more than 150 to 300 feet. Over rough terrain the system would obviously be inaccurate as high points would be shown incorrectly on the photographs and the resulting maps.

Canada has developed the oblique method to a high state of perfection and it is ideally suited for her conditions, although it has not as yet been adopted extensively outside the Dominion. Credit for the development of this oblique system, as well as for much other Canadian aerial surveying pioneer work, must go to the late Dr. Déville, Surveyor General of Canada. His pioneering efforts have been ably carried on by Athos M. Narraway, '14, who is Chief Aerial Surveys Engineer of the Department of the Interior of the Dominion Government, and in the department of J. D. Craig, Director General of Surveys for Canada. Actual flying operations are accomplished by the Civil Government Air Operations at the Department of National Defense of Canada which is headed by Group

Captain J. L. Gordon. From an office in Ottawa the department directs the movements of 22 airplanes, the crews of which throughout the summer season, are engaged in mapping operations, mostly over uncharted and unexplored areas. During the period from 1920 to 1929, 100,360 square miles were covered by vertical photography, and 238,715 by oblique, or a total of 339,075. In all, 355,585 photographic exposures were made.

These figures can best be appreciated by the statement that in 10 years Canada has covered an area one-fourth as large as the U. S. Geological Survey has covered in a period of 50 years. Since its founding 46% of the area of the United States, or 1,331,787 square miles, has been topographically mapped and progress is being maintained at the rate of 17,000 square miles per year. The use of ground methods serves to plot the topography more accurately, but they cannot secure the great masses of detail given by a photographic survey and, at the present rate of progress, the map of the entire United States will take 90 years to complete.

To cover the 17,371 square miles that the United States Geological Survey covered in 1929, it had 200 parties in the field. On the other hand, Canada had only eight photographic units to cover 74,655 square miles during a single season. Each unit consisted of two airplanes and two cameras with about six men to a unit. Of course, there were various ground survey parties in the field to furnish the control data necessary in compiling maps from the aerial photographs but much of the control data is taken from existing maps and often astronomical observations are used. The areas being surveyed are so remote from triangulation or other positive ground control systems that it is impossible to carry the control to the location.

The unit is under the command of a flight lieutenant who is a pilot and, in addition, the personnel consists of two sergeants who are also photographic pilots and one mechanic or air engineer as they are designated in Canada. Each of the two cameras has two different cones embodying lenses of different focal lengths. It is customary for a unit to have cones containing lenses of 8- and 12-inch focal lengths. The two different cones are necessary as a unit is often required to work on different projects where conditions require photography at varying scales and altitudes. The cones are readily interchangeable, and a complete change can be made in five minutes. Each camera is equipped with five extra roll film magazines, and these magazines can be loaded with film and carried into the air ready for use. It is only a matter of a few seconds to remove one magazine from the camera and substitute another completely loaded, thus obviating the necessity of daylight loading in the air. Other equipment consists of tool kits, trunks, camera sights, oblique mounts, tripods, and swivel bases for the oblique mounts, special mounts for taking vertical photographs, filters, view finders, dark room tents, switch boards, signal lights, photographic timers, drift indicator disks, etc. Most or all of this equipment must be transported to the temporary base of the airplane.

A few of the requisites of a photographic airplane are absolute longitudinal, latitudinal, and directional stability at all speeds and altitudes, a high ceiling, ability to climb to ceiling rapidly, great cruising radius, excellent visibility including a window in the floor so that the pilot can see the ground under him, reliability of airplane and engine permitting operation over wilderness country and extreme ruggedness. Most photographic missions are carried on in inaccessible regions hundreds of miles from the base of supplies or repair stations. The plane must fly without fail on every good photographic day as such days are at a premium and every one must be utilized.

Flying boats and amphibians are used for the oblique photography since it is necessary to mount the camera in the nose of the airplane. Pusher propellers instead of tractors make such a mounting possible. Furthermore, the boats and amphibians used are of the open cockpit type and this feature is necessary for oblique surveying. For vertical surveying the camera is mounted on the floor as shown by the photograph on page 128.

Aside from the United States and Canada there exists abundant evidence of the onward march of aerial surveying. Besides the mapping of Northern Rhodesia the Aircraft Operating Company, Ltd., has an 11,000 square-mile project in Zambesi. A companion British company, Air Survey, Ltd., during 1929 carried on programs in India, the Straits Settlement and Egypt. The work in India involved cadastral surveys (i. e., surveys to facilitate the collection of land revenues) of approximately 2,500 square miles at six inches to the mile; surveys for the Indian railways and for governmental irrigation operations; municipal maps for the City of Indore and the Port of Calcutta. In the nearby Straits Settlements Georgetown, on the island of Penang, was mapped.

Extensive operations have been carried on by Brazil, including air maps of Rio de Janeiro, São Paulo and other centers. The maps of Rio were completed in three years whereas ground methods alone would have required ten years. Also Chile contemplates a governmental survey of much of her territory.

But, in Iraq, an air survey of 1,500 miles for irrigation and agricultural purposes has disclosed a new by-product. There in Mesopotamia, the utility of aerial photography is being made apparent to assist archeologists engaged in probing the remains of the ancient civilizations of the Tigris and Euphrates valleys.

The five-year plan of Soviet Russia calls for a gigantic aerial surveying program. Their conditions are quite similar to those in Canada and there are vast areas in Soviet Russia, particularly in Siberia, which are without any maps of any description.

The original five-year plan of the U. S. S. R. calls for 140,000 square miles to be mapped from the air during 1931–1932 with an even greater amount of territory to be covered during 1932–1933. But the five-year plan is being speeded up and it is the present plan of the government to accomplish the entire five-year program in four years. This means that the areas to be covered during the next two years will be even greater than those called for in the original plan. The Russian program calls for even more surveying from the air than that of Canada which heretofore has been the most extensive of any nation in the world.

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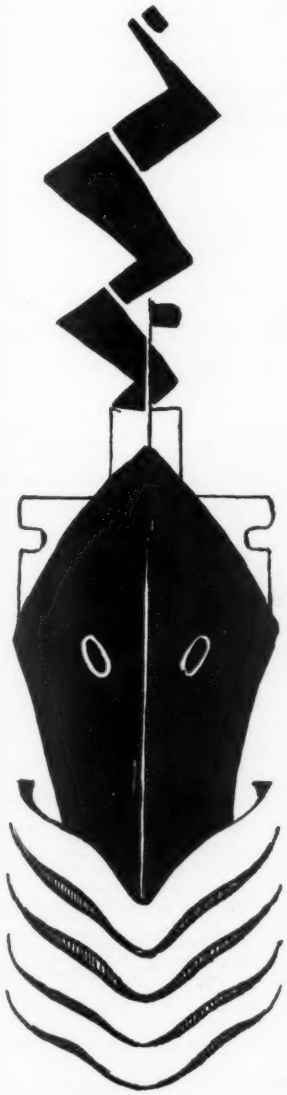

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RADIO'S GROWING PAINS

(Continued from page 126)

Congress did not take into consideration any engineering matters pertaining to the phenomenon of radio transmission. It was based almost entirely on the theory of states' rights. Going from east to west, the per-square-mile population decreases; therefore, radio service decreases by Act of Congress as you travel from New York to San Francisco. This, of course, was not what Congress had in mind. As an example of how this works out, it may be stated that one small eastern state has 12 times the radio facilities of a large farming western state. The farmers in the western state are far more dependent on radio facilities than are the residents of the eastern state, devoted largely to manufacturing. It is absurd that they should be given but one-twelfth the service of the eastern state.

In fairness to the Commission in its delay in making the reallocations, which delay brought about the Davis Amendment, it should be stated that the original Commission was set up only as a temporary body, lacking in funds, and perhaps unwelcome politically. It did not have the necessary legal advice, and the Commissioners questioned the very legality of their existence as pertaining to many of their duties. In fact, only during the current term will the Supreme Court pass on the validity of the Radio Act of 1927. The essential question is whether the right to use a broadcasting station is a vested property right which cannot be taken away by the Federal Government without just compensation. The point is brought about by the question, did Congress by the passage of the Radio Act of 1927 have the power to terminate all broadcasting rights, except under a license granted by the Federal Radio Commission?

In the last session of the present Congress authorization for an adequate engineering division of the Federal Radio Commission was given. A real attempt is now being made to provide a plan for the proper allocation of radio facilities throughout the country. There should be a real improvement in the near future. Preliminary steps were taken to make changes that would bring about such improvement, but immediately, a station involved in the reallocation brought suit to retain its present assignment. This completely tied the hands of the Commission, so that no new reallocation will be made until this suit is tried.

The Supreme Court recently rendered a decision that was most helpful to the Commission. Previously, the Court of Appeals had not only considered that it might pass on points of law, but went so far as to interpret these points of law as to passing on the regulations of the Federal Radio Commission to the extent of making specific station assignments when the Court decided in favor of the broadcast station appealing to it. This assignment of frequencies to stations by the Court of Appeals has been denied.

One of the most perplexing problems at the present moment is that of the power used by broadcast stations. This all goes back to the fact that by international agreement there are only 950 kilocycles available for North American broadcasting. It has been found necessary to allow ten kilocycles between *(Continued on page 154)*

Mr. Gerard's 64 "Men Who Rule the U.S.A." — Do They Take The Wall Street Journal?

EVERY newspaper reader is familiar with Mr. Gerard's recent list of 64 men "who rule the United States". The use of the word "rule" is of course a figure of speech. It would be more accurate to call these men leaders of business in the fields of credit, communications, transportation, electric power, basic raw materials, entertainment, and labor.

As a matter of testing our claims of The Wall Street Journal's capacity to render a valuable service to business and financial executives, we checked Mr. Gerard's names and the companies they represent against our list of subscribers and found 61 out of the 64 "rulers", or their companies, subscribers for The Wall Street Journal. A score of 95.3% subscribers among a recognized list of business and financial leaders is a record which few other publications can even approach, let alone equal or excel. Of the only 3 of Mr. Gerard's "U. S. rulers" who are not either individually or through their companies represented on our subscription list two are labor leaders, and one has extensive forestry and lumber-rather than directly financial-interests. Eliminating the two labor leaders and reducing the list to 62 our check-up shows 61 out of 62 business and financial leaders or their companies subscribing for The Wall Street Journal. A score of 98.3%!

Mr. Gerard's list is reprinted below

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RADIO'S GROWING PAINS

(*Continued from page 152*)

stations; therefore, the number of channels is immediately limited. Deducting those assigned exclusively to Canada there are only ninety channels, including Canadian-shared channels, which are available to the United States. There are approximately 600 broadcast stations, and pending are applications for new stations. One high-powered station, which at the present time means approximately 50 kilowatts, will render that channel useless to other stations. If all stations used this power it would be necessary to cut the number of broadcast stations very materially. The exact amount of the cut cannot be stated, because all the present 600 stations are not permitted to operate on full time. As ten kilocycles is not sufficient separation for 50-kilowatt stations located near together, it is doubtful if more than 75 broadcast stations would be possible in this country if they all used 50 kilowatts of power.

The Commission has before it the question of the advisability of limiting the number of broadcast stations to this number or to permit a much larger number of stations to operate, most of which would be required to use small powers, that is, not over 0.1 kilowatt. Various canvasses of listeners have been made. They in general tend to show that high-powered stations, putting on the very best programs, using chain systems, are preferred. Many local communities, however, have their own favorite local station, therefore, there is no unanimity of opinion.

Suppose that the listeners did agree on the plan of a very limited number of high-powered stations, and that the Commission put such a plan into effect. From existing experience, it is evident that the ownership of these stations would be in the hands of a very limited group. Is it wise to place such a potential force as radio broadcasting in the hands of any one group? In all analogous cases, public sentiment has not favored such a concentration of power.

The limited radio facilities make it impossible to assign full time to many stations. The very high cost of station equipment for stations capable of putting out the very best in programs makes it uneconomic to operate on part time. Furthermore, licenses are not transferable, so that two half-time stations may not combine their facilities and operate as a single station, without authority from the Federal Radio Commission. There is always the question as to whether it is for the public interest to permit such combinations.

The broadcaster is in a most hazardous position. His license, by act of Congress, has been issued for a period of ninety days, at the end of which time he does not know whether or not his entire equipment will be rendered valueless through the refusal of the Commission to renew his license. Should he expand his plant, and give the public better service? It has been a hazardous thing for him to do, without some assurance that his station would be in operation for more than ninety days. The Radio Commission has taken a very sane attitude on this problem, and in spite of the perplexing problems involved, has tried to administer the Radio Act not only for the public convenience and necessity as it is required to do, but with human consideration for the broadcaster.

(*Continued on page 156*)

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RADIO'S GROWING PAINS

(Continued from page 154)

During the last session, Congress amended the Radio Act of 1927, so that the Federal Radio Commission is empowered after January 1, 1931, to issue broadcast station licenses for as long as three years.

The broadcaster has other problems than that of retaining his license. There may not be played from his station any piece of copyright music without paying a fee to the copyright owner. He, therefore, must check every piece to be played by orchestras engaging the facilities of his station. He is, however, primarily interested in maintaining a large listener interest; therefore, he does take out a license, and sees that the copyright fees are paid. But what of the programs when they leave his station?

If the proprietor of a hotel or other public place picks up these programs for the entertainment of his guests, must that proprietor in turn pay a second copyright fee? The owners of the copyrights have insisted that he should, and have brought suits to enforce such payments. The Supreme Court at the present time is considering, among four similar questions, whether "the acts of a hotel proprietor, in making available to his guests, through the instrumentality of a radio receiving set and loudspeakers installed in his hotel and under his control and for the entertainment of his guests, the hearing of a copyrighted musical composition which has been broadcast from a radio transmitting station, constitute a performance of such musical composition within the meaning of 17 USC Sec. 1 (e)."

This matter is of great importance, because if the Supreme Court should rule in favor of the owner of the copyright, there will have been fixed no limits as to how far the term "public performance" may be extended. It may even come to the point of extending to homes when a radio program containing copyright music is played before a group other than the ordinary and usual residents of that house. It is a problem of vital interest to the radio industry.

In the protection of their own interests, unions have always bitterly opposed the extension of any appliance tending to decrease the employment of its own group. The improvements made in electric recording and reproduction have made it possible to place music on the air through a radio station, the quality of which is essentially equal to that of the original. Many stations use such methods of producing programs during the morning hours. The listeners as well as the owners of the stations feel that their interests are better cared for by mechanically reproduced programs from the best orchestras than by listening to programs by local talent.

The musicians' unions have claimed that this infringes on their rights, and in several cases have insisted that the man operating the reproducing *(Concluded on page 158)*

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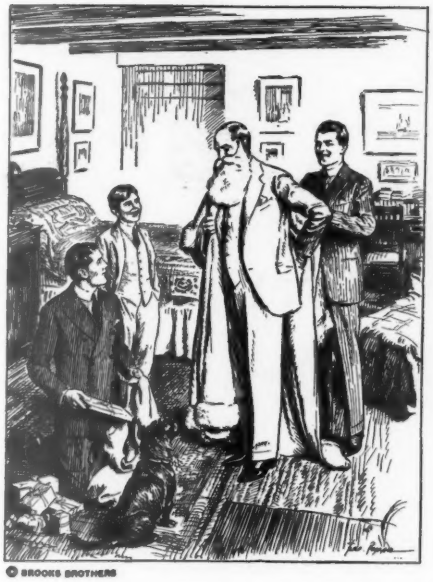

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RADIO'S GROWING PAINS

(Concluded from page 156)

device, which requires only the same skill as that of playing an ordinary phonograph, be a union musician, and be paid as such. Radio has, however, provided additional employment for many musicians. It has increased their working hours, rather than decreased them; therefore, it is felt that his union problem may be solved without much difficulty or inconvenience to the public interest.

While the engineering and economic problems confronting the radio industry are of great magnitude, such a condition would be expected in any industry which, within a decade, has grown from an annual business of but a few million dollars to one of a billion dollars. Radio is today one of the nation's important activities. It has a wide public interest. Such classes of business have in the past always been able to bring about a solution to their difficulties, and radio should prove no exception.

THE ANATOMY OF X-RAYS

(Concluded from page 132)

Gillette safety razor blade, but without success. Had he used instead of the safety razor blade the edge of any crystal, as for example, quartz or rock salt, he would have found that the x-rays passing through it would be deviated in a great variety of directions, and would form a complicated pattern on the photographic plate which was used to indicate their destination. It was just such a complicated pattern on a photographic plate, produced by a beam of x-rays passing through a crystal, which led the three German scientists mentioned above to the first proof of the wave nature of x-rays and to a measurement of their wave length.

When one considers that this important and varied series of practical applications and scientific discoveries have followed as the result of the curiosity of a few scientifically trained men, and that this is but one of a great number of similar developments of the past generation, one cannot but wonder at the possibilities which still lie open in the future.

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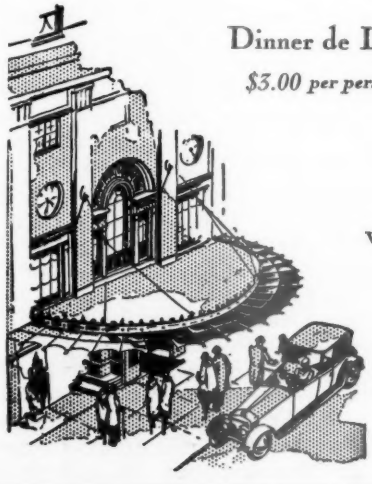

WALTON H. MARSHALL
Manager

AMERIKANISMUS

(*Continued from page 134*)

this and that famous American project. An article in the latest number of a prominent weekly devoted two pages of illustrations to the topic "What a German would find highly inconvenient in America" — an example or so will suffice: the hotel night-table containing *only* a radio set and an unhandy form of telephone; the one-arm quick-lunch chairs "made purposely as uncomfortable as possible so that the guest will be glad to leave as quickly as he can and make room for the next!"

So much for the feeling that shows on the surface. It seems bitter, unfriendly, almost insulting at times, but if we consider once again our earlier discussion as to underlying causes, the whole resolves itself into what is, really, envy, jealousy that such an adolescent nation can without effort take her place in the world while she, Germany, is chained almost to a standstill. What she says and publishes is not for us here across the seas; it is for herself, an attempt at self-consolation. Yet we are still apt to take offense at this effrontery, we are prone to forget that the German may speak heatedly but very seldom emptily, and that there is a kernel of truth, whatever his underlying purpose may be, in every fallacy he finds in us. It is equally childish and useless for us to call bad names in return or to hold our fingers in our ears; these fallacies are after all our fault, and at that not beyond repair.

Our migration every summer to do Europe in eight or ten weeks has played an undue part in branding America as a country of unbred, common, money-made people. Our tourists may be typical of our nation — surely Europe has every cause to draw this conclusion — but heaven help our land if they are! Picture a crowd of loud-mouthed, carmine-lipped women thumbing over every bit of lace or jewelry in a shop — "No, we aren't buying, just looking!" Picture the throngs at the "American" bars, tanking up till the next trip across. Listen to the sniffs of disdain at an old cathedral that has withstood the test of centuries — "Who ever built the way *we* are doing?" Yes, indeed, Europe caters to us; we have made Oberammergau the commercialized production that it is; we keep scores and scores of towns in business by our annual visits. They cater to us — that is business; but respect is another matter — what barker at a county fair ever respected the throngs that filed from one exhibit to the next?

Behind this conscious and justifiable belittling and ridicule and wholesale criticism, there is a far more respectful feeling, *but for the land, and not the people!* Liesl admits she would go across immediately were the opportunity offered. Scores of students and young engineers have asked me what chances they would have were they to seek their fortune in our country. Not a family but what has relatives or friends already settled in the States, from whom come glowing tributes to the opportunities of this land of promise. But beneath it all is a trace of doubt — Liesl phrased it rather aptly when she ventured, "I'd like to work there — but live here."

No doubt Liesl was only repeating the ideas of another, and would find America a perfect paradise of amusement; we cater particularly to minds like hers. Therein lies what the German considers the distinguishing feature between our two worlds: we have developed Civilization, they, *Kultur*. We live a perfected, systematized, bodily and sensually luxurious existence at a tremendous pace, seeking with ever greater speed a goal whose nature we do not even bother to wonder about; that is Civilization. They feel they have long since found their goal — the finer cultivation of the mind — and they can enjoy their higher life without haste. The German visitor in America misses his accustomed leisure in which to appreciate life. The American in Germany curses the lack of conveniences.

So, be it strictly true or not, we have given the Germans good cause to believe that the United States is a land of wealth and wealth worshippers. How can they believe otherwise? Tourists fairly reek with money, or try to give that impression. Press reports are profuse in their tabulation of huge American financial transactions. An expenditure of hundreds of thousands is sheer waste and display in the light of the German's forced thriftiness. Luxuries to a German are things he has learned to do without, yet to an American they have become the very mainstays of existence. With reports of the recent market panic and unemployment menace in America, Germany almost gasped; the U. S. A. in financial trouble? The rumors continued to come, but so did the tourists and the reports of huge expenditure and business deals. Hence our money crisis is largely a myth to the average German mind and America is still the land of millionaires.

To the German it would seem that we have the horse and cart most assuredly in reverse order: had our wealth been the obvious result of leadership in education, science, and the arts; or even had the growth of all been more simultaneous, it would have been respected. But financial prestige came first, and what nation could not buy the rest once given sufficient resources? Perhaps the respect for more than our wealth will follow in the course of the years, but only when the German race begins to feel that America is producing from its *own* talent, and not buying from the rest of the world.

FROM the surface matter, the self-alleviation of her wounded pride by ridicule, we have gone a step deeper into Germany's feeling toward us; but there is yet greater depth more seldom encountered. In the number for March, 1930, of the "*Deutsche Rundschau*" I chanced upon an unusual article, "*Amerikanismus als Schlagwort und als Tatsache*" by Theodor Lüddecke. He has departed entirely from the usual attitude, and in unbiased writing, so candid with his own countrymen that America is discussed in almost flattering terms, he analyzes "Americanism" in its actual and hypothetical influence upon the German race. He too writes, not for us, but for his own people; yet, though his general theme as applied to Germany does not concern us at this time, many of his remarks are so pertinent that I quote a number as I translate their meaning.

He begins, "The term *Amerikanismus* is today almost at the center of every explanation of political, economic, or cultural questions. The commanding political position of America, which she has won directly through her economic powers" brings forces to bear which "influence the destiny of us all to an ever greater (*Continued on page 162*)

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AMERIKANISMUS

(*Continued from page 160*)

degree. . . . We have no longer the definite choice of acceptance or refusal — the American forms of life are, through economic channels, simply forced upon us."

But he notes rightly that what Germany terms *amerikanisch* is often far more "Americanized" than the original — modern youth, for instance — and develops the interesting thesis that "Americanization" is simply a process of national evolution, that the United States happened to reach this stage before the rest, and that "Americanization" would just as surely have come about had the U. S. A. never existed!

The American, as such, is in his life-force still younger than the European, but in his methods of living and working already far older. Why? Because we are not, like European states, the direct product of centuries of development; we took instead a strength and self-dependence from Europe to a land of endless resource, a land filled with the challenge to be conquered. "But no thought of self. No consideration for matters without direct practical value. There is not time for that. This part of the earth can only be conquered through toil. And thus did work become the leading principle of American religion and philosophy. This the German philosophers term Pragmatism and do their best to refute. But Pragmatism cannot be 'refuted'. . . ."

"America knocks at our door. What is this America anyhow with which we have to do? It is basically an industrial mass of extremely lively, adaptable youths, who — optimistic, humorous, athletic — seize every task within possible reach, are without limit in endurance, and feel themselves equal to every situation. Perhaps they are, in the words of a German professor, uneducated in the higher sense (*höchst ungebildet*), but they are, however, thoroughly trained (*gut durchgebildet*) — physically as well. They are at least well enough educated to buy up our German factories."

Our abnormal addiction to sport has not been without its marked result. He remarks that the Americans, from laborers to business directors, taken as a whole, are more in form than the inhabitants of almost any other land. An American 'stands out' when he strolls through Berlin. He is radiant with an energy that everyone notices. "*Wie kommt denn das?*"

"The American features are freer from care. In no land in the world is there so much laughter as in the U. S. A. Granted — the American has it easier; the natural opportunities of his land offer an almost boundless field of activity. He permits no damming-up of his intellect. European visitors frequently affirm that America is problemless. Little wonder. When the whole land is 'in form' . . . when the people and the conditions are healthy, then even the unsolved problems are trifles. The people live intensively; they live not only with the head, but with the whole body. They have so great a surplus of life-force that it often takes the form of childish gayety. One is always surprised anew at the natural freshness that the American spirit shows."

But he does not deny that there exists in America a certain monotony, and that directly on that account the higher classes seek closer connection with Europe, where a great warmth seems to be given forth. To him it is clear that the robust instinct of our early pioneer, his natural freshness, is already on the wane.

His views on comparative politics should be encouraging to us to say the least. One returning from America and viewing the German situation, he observes, is wont to quote Romain Rolland's "Too many clever minds are busying themselves with the State." As a German voter once remarked to me, "Every German wants to have his say in politics; you Americans are wise — you leave it to the politicians." Lüddecke continues, "Men who otherwise understand each other very well, become irate once the discourse touches on politics. Talk begets neither potatoes nor automobiles. . . . America has developed herself through work." Nothing can satisfy all parties as well as a "rational production of new products, through which all pull on the same rope. That is basically the secret of the American economic morale. . . .

"In other words, the economic attitude of mind has so taken hold of political thought, that politics have received an entirely different character. America maintains a strong army and a strong navy — however, when one talks in terms of peace, that is no empty way of speaking. This attitude is entirely an outgrowth of the American principle of predominant economic thought. This has nothing to do with Pacifism. Pacifism is — say what one will — surely no sign of strength. America is conquering the world, perhaps to a far greater extent today than any nation has ever done. She conquers, however, with different weapons — that is, without weapons, by means of economic superiority. Militarily she lies on the defensive; from the economic point of view she is absolutely on the offensive."

If we are content to be typically American, and neglect to fill in the countless little "exception" sub-headings which Herr Lüddecke has left for us in his somewhat rosy outline or correct his obvious errors, we may now smile a bit triumphantly. "Herr Lüddecke has found us the greatest nation of all times, and he's not so far wrong at that; we're showing the old world a thing or two in greater business methods." Ha — "money-chasing people"! "What," asks Lüddecke of his own nation, "is the use of all the cheap patent ice-chests and automobiles, when the spine of the *Volk* is crushed? The economic moment can be for us only the means — never the end."

But what is it to America? If only a means, then to what purpose? Is there a single soul in our nation who knows why we strive, why we build, why we live at our tremendous pace? Was Liesl far from the truth when she branded us as merely "money-chasers" — have we a greater goal in mind than what the dollar signifies? No doubt the reader will balk a bit at this point; "It's not the dollar we're after; it's Progress!" Good enough; but whither?

Lüddecke tells of the technically-inclined Englishman who read Goethe's "Faust" to the end, and then exclaimed triumphantly — "Yes, but the German Faust died as an *engineer!*"

At the moment that is the most a great many of us would think to wish for. "Decisiveness, magnitude of vision, the joy of doing, and cold calculation in economic matters — America teaches these," says Lüddecke. Perhaps we in turn can take a lesson (*Concluded on page 164*)

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AMERIKANISMUS

(Concluded from page 162)

or so from Germany. "We have all that we need, and more than we can ever use. We have large bank balances, villas, autos, yachts — the one thing we lack is — Time! Our minds are fixed on production. And now the whole machine is dragging us along. When our nation was young, perhaps we would have willed it otherwise — now that it could be otherwise, we have lost the will to change."

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BOOKS

(*Continued from page 144*)

connection with his studies on Arabic alchemy. On the other hand, the chapter on "Scientific Philosophy and its Outlook," pages 445–492, is clear and masterly, and can be studied with profit by all who are engaged in the pursuit of science.

The American edition differs only by minor changes from the English edition of 1929. Its price is two dollars less, but it is not as easy on the eyes for it appears to have been made from the English edition by a process of photographic reproduction. TENNEY L. DAVIS

Essays on Modern Magic

THE SCIENTIFIC AGE, by Dugald C. Jackson and W. Paul Jones. $2.00. v+353. New York: *John Wiley & Sons.*

IN THIS volume Professors Jackson and Jones, both teachers in the Speed Scientific School of the University of Louisville, present 23 previously published essays all having more or less to do with "this scientific age." Although the book is intended to be used as an English text in engineering schools, it should enjoy popularity with a general audience interested in science but not too well informed in that modern magic. The essays range in value of content from Michael Pupin's description of how he made good in a big way as a Columbia undergraduate to Bertrand Russell's masterly ten-page exposition of materialist philosophy. They have their ups and downs between these two points, the somewhat infantile styles of some of the popularizers being balanced by good papers from Stuart Chase, Paul de Kruif, H. G. Wells, and other able writers. On the whole, the authors seem well chosen; but Hendrik Van Loon and Albert Edward Wiggam could profitably be traded for Julian Huxley and J. B. S. Haldane, who are excluded.

To this reviewer it seems that Messrs. Jackson and Jones are working on a false hypothesis. Experience has shown him that Edwin Slosson, Paul de Kruif, and their kind will be avidly read by engineering students without any guidance or prodding from the English department. What they should be given, in what is often the one "arts" course they take, is an introduction to the type of literature they would normally not deign to examine. Many an "arts college" boy has been dragged kicking and struggling to the science department for a forced feeding of chemical or biological learning, only to find on closer acquaintance that there was something there worth his time and worthy of his interest. "What's sauce for the goose is sauce for the gander!"

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Technology Review

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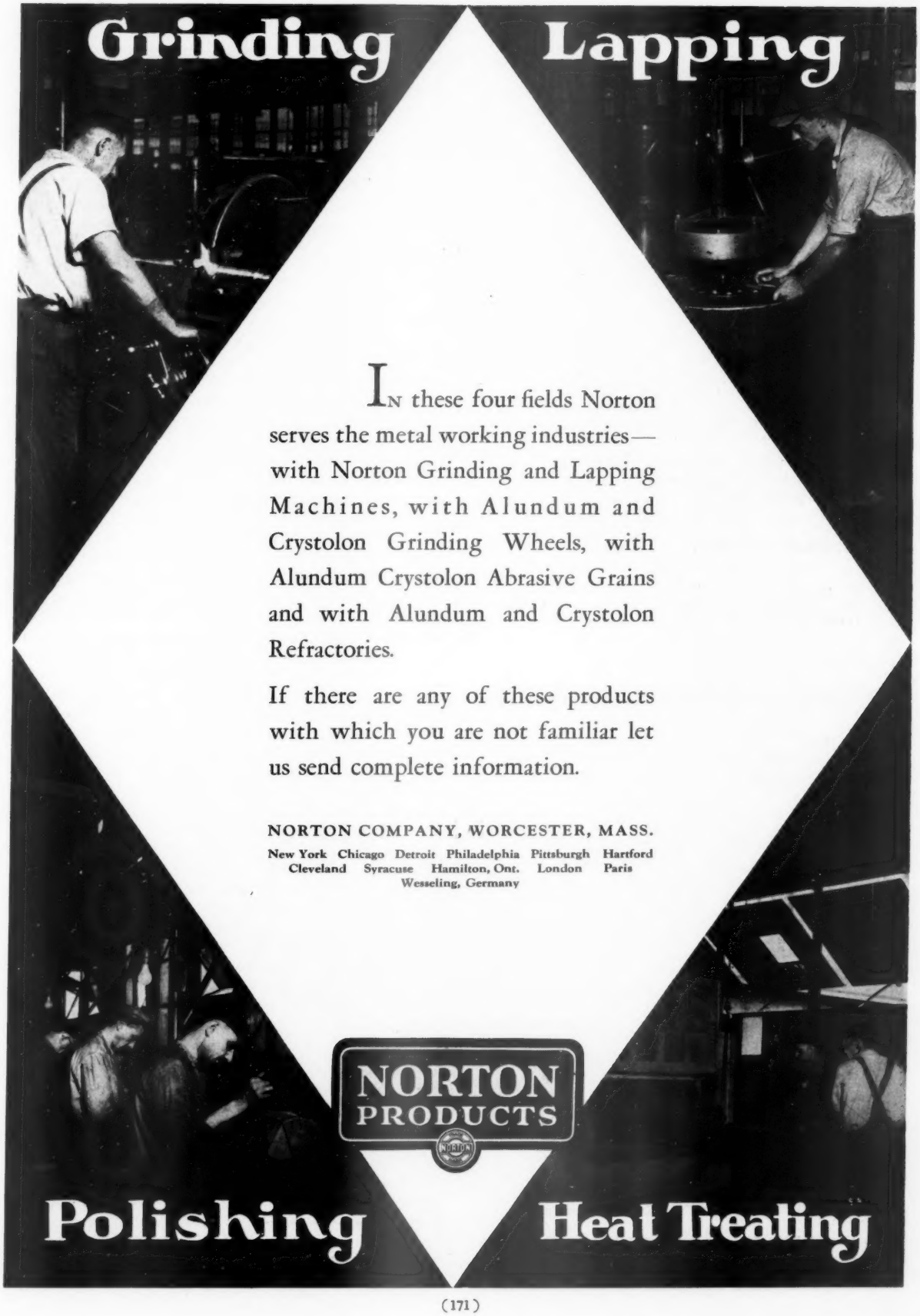
THE TABULAR VIEW

READERS of The Review have in a very gratifying way signified their appreciation of its monthly survey of scientific and technical developments. The many letters we have received indicate that items which have appeared in the "Trend of Affairs" section not only have informed Review readers but have suggested to them industrial opportunities and warned them against the all too common fads and frauds of pseudo-science. In preparing this section we do not pretend to completeness, but we are desirous rather of including in it as great a variety of interesting and valuable information as can be focussed in so small an area. ¶ Toward this end The Review has acquired the services of two more contributing editors who will add each month important and interesting items from their particular field. With this issue Tenney L. Davis, '13, Associate Professor of Organic Chemistry here at the Institute, and W. P. Cutter of the Harvard Business School begin their monthly contributions to this section. For this issue, Professor Davis prepared the article on "Alchemy in Old New England" and Mr. Cutter the article on windowless buildings. Review readers, we are sure, will welcome these new contributors.

FEW men who are not themselves scientists or engineers have more to say to members of those professions than Charles A. Beard, authority on American history, on government, and on American civilization. He has inquired into the meaning and effect of modern technology with more care and perspicacity than probably any other American scholar. It will be recalled that several years ago he edited a book entitled "Whither Mankind" which advanced the thesis that what is called western civilization as distinguished from other cultures is, in reality, a civilization of technology resting at bottom on science and machinery. It will also be recalled that this book was followed by another symposium called "Toward Civilization" in which a group of scientists and engineers inquired into the "dynamics of their laborers with particular reference to the human aspects." In that volume Professor Beard contributed an admirable introduction and summary, distinguished alike for its sympathetic attitude towards the methods and spirit of technology and by a dispassionate criticism. "Engineers," wrote Professor Beard in that book, "recognize the significance of that marvelous instrument of the human mind — the invention of invention, although they rely upon it for making immense advances in the future, they still find that electric fluid, imagination, absolutely essential to the achievement of results in the realm of the unexplored and unprecedented. Without it, science and engineering become dogmatic and sterile. It must be and is being cultivated and nourished as one of the essential forces of the modern world. Imagination, informed by the known laws of nature, but unbound and free to experiment and dare, combined with the spirit of rationality, lives and flowers in the engineering age and will swing new planets into the ken of those who watch the heavens for signs of the future."

(*Continued on page 172*)



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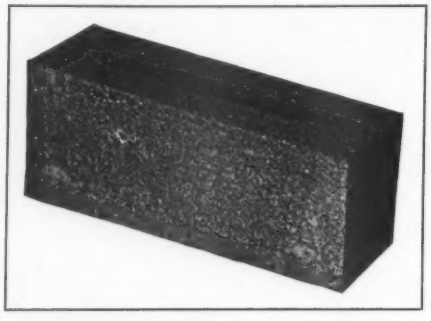

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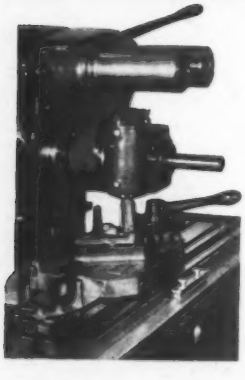

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THE TABULAR VIEW

(Continued from page 170)

¶ Because Professor Beard sees the modern scene so clearly, and because he appreciates and understands the problems and motives of the scientist and technologist, The Review is particularly happy to present in its pages an article by him, written in collaboration with his son, a graduate of the Institute in the class of 1928.

THE article, "Machine Age Politics," is a development of one of the theses set forth in "The American Leviathan," the book that has just been published by Professor Beard and his son. The Beards in their article point out what technology has done to government. The fact that it plays so large a part implies a responsibility on the part of engineers, a responsibility which we are optimistic enough to believe the more intelligent and informed engineers realize. ¶ As evidence of this we point to the formation of the American Engineering Council in the spring of 1917. This body, representing 57,000 of the leading professional engineers of the United States, has as its object the furthering of public welfare wherever technical and engineering knowledge and experience are involved. In its actual operation the Council has assisted the federal government in every possible and legitimate manner on engineering questions. It has been able to thwart many unwise and ill-conceived enterprises and it has been able to suggest creative work entirely beyond the purview of the politicians. ¶ We cannot pass on without noting the versatility of the Beard family. Mrs. Beard was co-author with her husband in writing the "Rise of American Civilization" and she has also published books on labor questions. William was a brilliant student at the Institute, taking the Course in Civil Engineering. Professor Beard himself has a broad academic and professional background. He holds degrees from De Pauw University and Columbia and has studied at Cornell and Oxford University, England. For many years he was a professor of politics at Columbia University. From 1917 to 1922 he was director of the Training School for Public Service in New York City. As director of Institute Municipal Research in Tokyo and as adviser to Viscount Goto, minister of home affairs after the earthquake in 1923, he added to his knowledge of foreign affairs. At present he is living in New Milford, Conn.

FOR THE second time this year, Dr. Karl T. Compton writes for The Review. In "An American Faraday" he gives a comprehensive survey of the inventions of Elihu Thomson, director of the Thomson Laboratory of the General Electric Company, Lynn, Mass., inventor of electric welding, and holder of 700 patents for inventions in electric lighting. At the present time he is engaged in a new line of activity — constructing the largest telescope mirror ever undertaken. ¶ Since the writing of this article, the Society of Mechanical Engineers has conferred an honorary membership on Dr. Thomson for his distinguished work as an inventor. In the words of

(Concluded on page 174)

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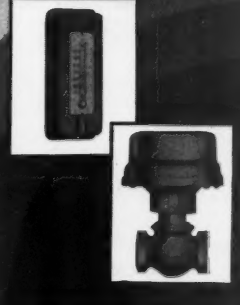

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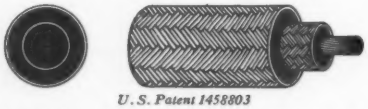

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THE TABULAR VIEW

(Concluded from page 172)

Dr. Compton, Elihu Thomson has "combined in a most remarkable way the constructive powers of the inventor, the thoroughness and soundness of the man of science, and the kindly balance of the ideal philosopher, teacher and friend." ¶ Dr. Compton has remarked on the difficulty he once experienced, as have many others, in disentangling the contributions of the Thomsons to electrical engineering. There are more than a half dozen "Thomsons" to be found in the indices of scientific histories. To clarify the situation we have listed below some of them, together with notes on their achievements:

JAMES THOMSON (1822–1892). A British physicist and engineer at Glasgow University, renowned for work in thermodynamics, hydraulics, and civil engineering.

WILLIAM THOMSON, LORD KELVIN, (1824–1907). A British physicist and brother of James. He proposed the absolute scale of temperature and put the dynamical theory of heat into such a form as to command universal acceptance. His work in the field of submarine telegraphy gave him his world-wide reputation. In all, he published more than 300 papers covering every branch of physical science.

SIR JOSEPH JOHN THOMSON (1856–). A British physicist at Cambridge University, who carried out epoch-making investigations on the conduction of electricity through gases, the determination of the charge and mass of the electron, and analysis by means of positive rays.

These three, together with Professor Thomson of Swampscott, have added immensely to our knowledge of electricity.

To round out the Thomson saga, two scientists of that name who have worked in other fields should be mentioned:

JOHN ARTHUR THOMSON (1861–), biologist.
JOSEPH THOMSON (1858–1895), explorer.

THE author of the significant article on the irradiation of foods, Mr. John J. Rowlands, is a Contributing Editor to The Review. He wishes to express his indebtedness to workers in the Departments of Physics and Biology of the Institute. Robert S. Harris, '28, associate of the Department of Biology and Public Health, conducted a 24-day experiment on rats, the results of which are shown by illustrations and the text accompanying them. Donald C. Stockbarger, '19, Assistant Professor of Physics, was likewise coöperative and helpful in preparing "Treating Food with Light."

THOMAS J. KILLIAN, who reviewed Sir James Jeans' book, "The Mysterious Universe," for this issue of The Review, was graduated from the Institute in the class of 1925 and received his master's degree in 1926. Later he received a Ph.D. from Princeton University. He is now an instructor in Physics at Technology and a member of the Research Laboratory in Experimental Physics.